AMERICAN ENGINEER AND RAILROAD JOURNAL.

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AN AMERICAN OBSERVER ABROAD.*

IV.

THE CREWE WORKS.

London & Northwestern Railway.

By W. F. M. Goss,

Professor of Experimental Engineering,

Purdue University, Lafayette, Ind.

The works of the London & Northwestern Railway at Crewe extend over an area of one hundred and sixteen acres, of which thirty-six are under roof. Within the works six thousand men find employment, and behind all and in all is the vigorous personality of the well-known Chief of Motive Power, Mr. F. W. Webb.

My trip to Horwich, concerning which I have already written, had prepared me for Crewe, for a similar business conception underlies both establishments. But the former is entirely a new creation, while the latter has been gradually brought to its present state from the small beginnings of nearly sixty years ago. Horwich, therefore, has the advantage of a more orderly arrangement, but Crewe is still the more extensive, and conducts a greater diversity of operations. Its forty or more shops include, besides those especially devoted to the construction and repair of locomotives and cars, others which serve in the production of various supplies and materials for the several departments of the road.

A rail-mill produces all rails needed for the tracks, work at the time of my visit being upon a 105-pound section rolled in lengths of 60 feet. The spring-steel used at Crewe, of which large quantities are required for the long flat springs of English cars, is all manufactured within the works. A fine shop, presenting a large unobstructed floor, and having a machine equipment near at hand, is employed upon switch, crossing, and special track work, while a neighboring department turns out great quantities of interchangeable equipment for switch and signal towers.

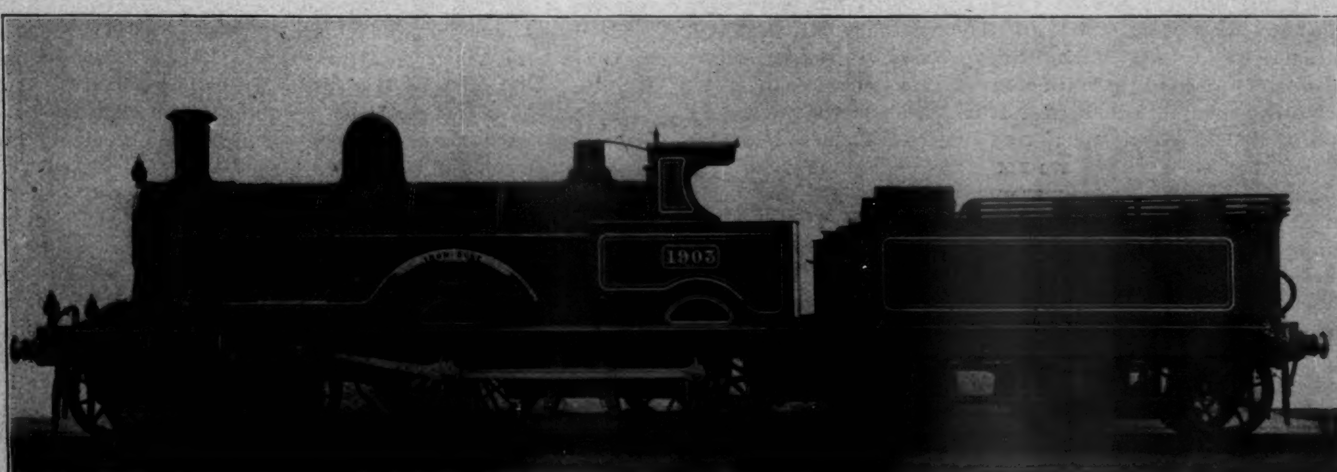
A general machine-shop builds machinery for water-stations, new shop-tools of up-to-date design, cranes of various types for freight stations, baggage-lifts for passenger stations, high-speed steam engines for driving dynamos direct-connected, and makes repairs on the machinery of the company's tug-boats and steamers. I found this shop well filled with new work in great variety.

The massive steel castings of a powerful hydraulic press designed for steel forging occupied the heavier machines, and the parts of a large lathe were being assembled on the erecting floor. All castings, whether of iron or steel, are products of the works.

Another department makes dynamos and the smaller electrical fixtures and supplies needed for crane work, and for station lighting. Out of doors an extensive brick yard is operated, the product of which is entirely consumed along the line, and in a corner of the pattern-shop, which is railed off from the rest of the room, most excellent wooden arms and legs are made for employees of the road who have suffered mutilation in its service.

It was impossible in a single afternoon for one to see even the external form of so large an establishment, but my understanding is that so far as is practicable, all manufactured articles needed by the various departments of the road are made at Crewe under the direction of the locomotive department, the value of materials supplied by this department to other departments of road amounting in round numbers to $4,000,000 a year.

An interesting feature of Crewe is its immense banks of



Four-Cylinder Compound Locomotive—London & Northwestern Ry.
Cylinders, High Pressure, 15 Inches; Low Pressure, 20½ Inches by 24 Inches Stroke.
Balanced on the Strong System.

*For previous article see Vol. 73, page 375.

coal. The explanation is that the road uses somewhat more than a million tons of coal a year, that the possibility of strikes at the mines makes delivery at a constant rate so uncertain that a large supply must always be carried. The piles are formed within retaining walls constructed of the larger blocks of coal, with sufficient care to give a regular outline and a smooth exterior surface. They rise to a height of eight or ten feet only, and extend along the lines of track from which the coal was delivered. All are without covering. Similar but smaller piles are to be seen at intervals along the road, and when near stations the exterior walls are not infrequently decorated with a coat of whitewash.

Mr. Webb has 2,800 locomotives, the heavy repairs upon which are made at Crewe. Many very old engines are still in service, and consequently there is a large number of different types to be cared for. Seven hundred engines, however, have similar cylinders and similar boilers. The boiler shop contains long rows of repaired boilers, ready to go out on any engine of the class for which it is standard. Other details have in some cases been standardized to cover a still greater number of engines; for example, it is said that, "there are but two eccentrics on the whole road."

The new work in progress includes an installment of heavy simple engines, and an installment of four-cylinder compounds, the two classes being quite similar except as to cylinder arrangement and the details depending thereon.

These locomotives in common with the new engines of the Lancashire and Yorkshire, to which I referred in a previous letter, have a "center frame" which in its present form at least, constitutes a new element in locomotive design. The center-frame is a deep cast-steel member, extending longitudinally from the cylinders to a cross-brace back of the main axle. Its purpose is to provide support for a third bearing on the crank-axles, for which the straight portion between the cranks serves as the journal. With the addition of this bearing, the full length of the crank axle, except that portion which is taken by the wheels and the webs of the cranks, is utilized as journal surface, a condition made possible by the use of the Joy valve-gear and the consequent absence of eccentrics. The center-bearing is not allowed to carry any considerable portion of the weight of the engine, but is designed chiefly to resist the thrust of the cranks.

Nothing which I saw at Crewe interested me more than the new compounds, which are referred to by Mr. Webb as locomotives of the "Black Prince" class. I was especially fortunate in seeing a half-dozen of them coupled together, which had been pulled out fresh from the shops for the inspection of the directors, and a very fine and business-like procession they made. They are not large engines, as Americans measure size, but they are more powerful than any previously existing type on the London & Northwestern Road. The wheel arrangement is that of the "American type," the four coupled-wheels having a diameter of 85 inches, and the four truck-wheels a diameter of about 50 inches. There are two 15-inch high-pressure cylinders outside of the frame and two 20½-inch low-pressure cylinders inside of frame, all of 24-inch stroke. The cranks on the axles are opposite those in the wheels, thus making possible a perfect balance of the reciprocating parts, the whole arrangement, so far as cylinders, cranks, and reciprocating parts are concerned, being similar to that of the Strong, balanced, compound locomotive which was tested at Purdue two years ago, and with which the readers of the American Engineer are familiar.

The Joy valve-gear of the engines of the "Black Prince" class takes its motion from the low-pressure connecting rod and communicates directly with the low-pressure valve-spindle, all as in simple engines. But the low-pressure valve-spindle is extended through the front of the valve-box where it connects with a rocker which serves to transmit motion to the high-pressure valve-spindle. Thus the valves of the outside cylinders are driven from the motions of the inside cylinders.

Comparing the new compound with the highest development of the Webb three-cylinder compound, which is represented by the class to which belongs the "Empress Queen," exhibited at Chicago in 1893, one finds that the engines are quite similar in several important respects. They have the same diameter of drivers and practically the same cylinder volume. The new engine is, however, designed for a pressure of 200 pounds, which is 25 pounds more than is carried by the "Empress Queen," and it is probable that its boiler has a greater area of heating surface, though judging from appearances alone the increase is not great. Since the new engine with dimensions but little increased as compared with those of an older type is regarded as much more powerful than any of the previously existing types of the road, it is evident that the designer attaches no small significance to those features of the four-cylinder compound which are new to his practice.

The English, generally speaking, are not now interested in the compound problem, but the vigor with which Mr. Webb has labored in its development has been uninfluenced by any lack of sympathy which he may have encountered. He began his experiments twenty-one years ago, and three years later built at Crewe his first three-cylinder compound, a type now generally known by his name. The number of compounds was soon after increased to thirty. Following this first lot there appeared at various intervals between 1882 and 1899 five other lots of from ten to eighty engines each, making the total number of compounds now in service one hundred and eighty, differences in the engines of the several lots representing progress in design, or being in response to the requirements of different classes of service. The twenty, four-cylinder engines now in process of erection will increase the number in service to two hundred. In a paper before the June meeting of the Institution of Civil Engineers, Mr. Webb describes his various types and testifies as to their satisfactory performance in service.

FLEXIBLE STAYBOLTS.

By F. W. Johnstone.

Superintendent Motive Power and Machinery.
Mexican Central Railroad.

I have for a long time been working on the staybolt problem and consider it very important.

The small blue print under date of Sept. 7th, 1899 (Figs. 1 to 4) represents the flexible staybolts as we are now applying them to locomotives on this road. We use very bad water on some sections of this road and the number of broken staybolts discovered each month is simply enormous. In one lot of nine engines running in a hard-water district we renewed 1,114 broken staybolts during the three months of August, September and October, 1899. All of our engines are inspected every thirty days, and broken staybolts are renewed immediately after the inspection has been made. These nine engines are all comparatively new, having been built since the spring of 1897. They were built by one of the best locomotive works in the United States and the best known grade of staybolt iron was used. The staybolts are ⅞ inch in diameter except the four upper rows on the side sheets, which are 1 inch in diameter, and all staybolts are spaced 4 inches centers. These engines carry 180 pounds of steam.

I estimate that we will have to replace more than 20,000 staybolts during the year 1900. Some of these bolts, which are easy of access, can be put in at a cost not to exceed $1.00, while others will cost $10.00 apiece, due to the labor of taking down and replacing such parts as the reverse lever quadrant, springs and spring rigging, etc. This matter of broken staybolts has become so serious that we were obliged to devise some method of reducing the cost of renewals and avoid throwing the engines out of service every thirty days to make these renewals, and we have settled upon these flexible staybolts as the remedy for the evil. Not one staybolt out of five thousand is found broken next to the firebox sheet; they are invari-

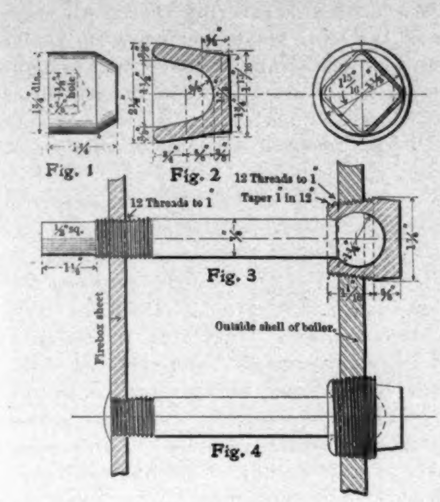


Fig. 1 Fig. 2 Fig. 3 Fig. 4

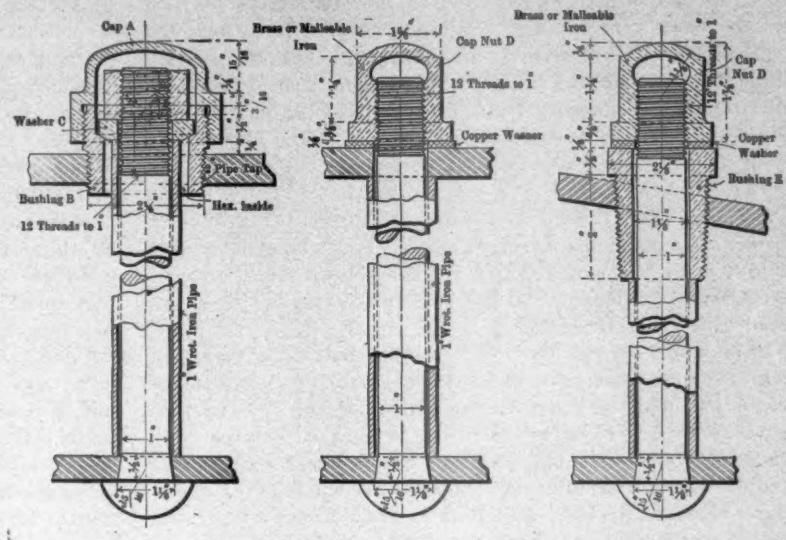


Fig. 8 Fig. 9 Fig. 10

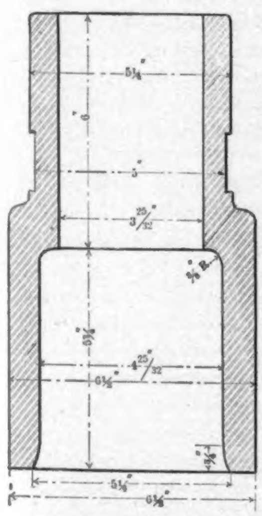


Fig. 7

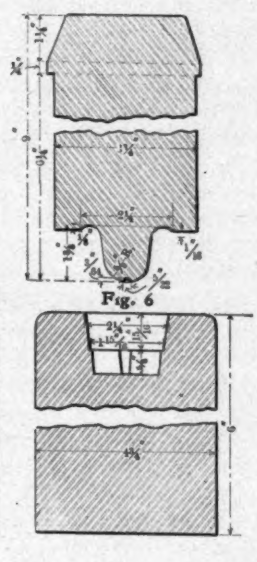


Fig. 6

Fig. 5

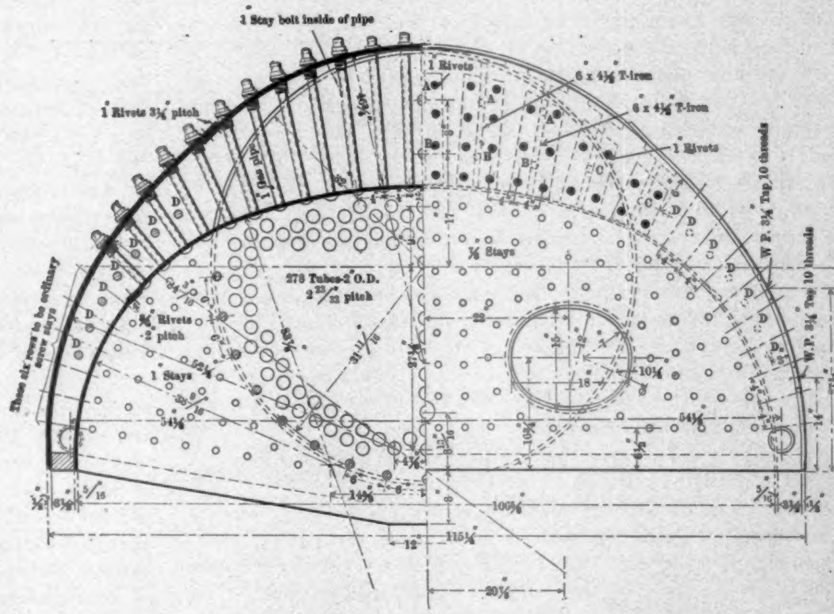


Fig. 12

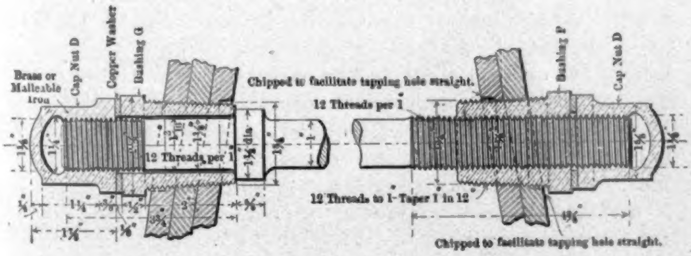


Fig. 11

ably found broken just at the inner edge of the outside sheet, and if we can make this portion of the staybolts flexible so that the bolt can adjust itself to the expansion and contraction of the firebox sheet, we shall overcome the difficulty of broken staybolts, and I believe we have accomplished this end. We have put a number of these staybolts in service and are putting them in every day, especially when renewing staybolts in the upper rows, as we find the largest number of them broken in the upper front and back corners in the side sheets, although we find broken staybolts distributed all over the firebox, even in comparatively new engines. Our present method of manufacturing these staybolts is as follows:

We use mild steel in bars 1¾ inch diameter, a piece 1¾ inch long is cut off of this bar and one end roughly hammered into a square, Fig. 1. These plugs are then put into a jig and a hole 1⅛ inch in diameter by ⅞ inch deep, drilled in the end. A number of the plugs are then heated together in a furnace, and as we have no drop hammer we use one of our steam hammers for forming the plug. The die, Fig. 5, in which the plug is formed, is placed upon the anvil of the steam hammer. The heated plug is dropped into the top of the die and a punch, Fig. 6, which is already inserted in the guide or holder, Fig. 7, is placed over the die, and one blow of the hammer finishes the plug in the form shown in Fig. 2. We find it necessary to put two handles on the punch guide, as it was too heavy for one man to handle.

The staybolt proper has a ball formed on the end in an ordinary bolt-heading machine; the thread on the other end of the staybolt is cut in an ordinary bolt cutter; as the staybolt is free to revolve in the plug, there is no necessity of the thread on the staybolts being cut in unison with the thread on the plug. The staybolt is then put into a chuck fitted to a small lathe, the tool rest of which is so arranged as to revolve around a pin immediately under the center of the ball. The tool post is fed up against a stop, and then the tool is moved around in a semi-circle by a hand lever. This

turns the ball on the end of the staybolt perfectly true and does the work very rapidly. The next process is to heat the plugs, as shown in Figure 2, and crimp or close them down around the ball on the end of the staybolt. At present we are crimping the plugs by hand, using a light flatter and light sledge, but we have designed a machine for doing this crimping by power, and when this is perfected the closing will be done by cheap labor. The last process is to cut the thread on the plug. This is done in a lathe, the thread being finished by running a solid die over the plug. The whole process of manufacturing these staybolts is done by cheap labor, and the cost of labor for manufacturing a complete staybolt does not exceed nine cents in gold.

I have made several tests of these staybolts and find that when the plug is screwed through the plate until the inside edge of the plate is opposite the center of the ball so that the plate offers no re-enforcement to the plug, it requires more than 20,000 pounds to pull the ball out of the plug. Where the plug is screwed into the plate, as shown in Fig. 3, the plate re-enforces the plug to such an extent that the bolt breaks under a strain of from 28,000 to 30,000 pounds without even loosening the ball in the plug. As these staybolts have to resist a strain of only about 3,000 pounds in service, we find that the staybolt has a factor of safety of from six to ten, and is therefore perfectly safe.

In tapping out the holes in applying these staybolts we use a hollow tap for the outside hole, inserting a rod to guide the tap. In tapping the hole in the firebox sheet, where we find it necessary, we use a bushing on the outer end of the tap simply to guide the tap, and as there is no necessity for having the holes tapped in unison with each other, they can be tapped separately and there is no danger of stripping the thread on either end of the staybolt.

In applying the staybolts, one man screws in the plug from the outside, while another man on the inside of the firebox turns the staybolt. The plug and staybolt are free to adjust themselves to the threaded holes in the two sheets, and are readily screwed into place. After the end of the staybolt is cut off on the inside of the firebox it is hammered over in the usual way, a holding-on bar being placed against the back of the plug on the outside of the firebox.

In Fig. 9 is shown our standard crown stay. This consists of a through bolt with a button head under the crown sheet, a spacing piece formed of 1-inch gas pipe between the crown sheet and the shell of the boiler, and a cap nut screwed on the upper end of the stay with a copper washer under the nut. We have a number of Belpaire fireboxes, which have been running for several years, equipped entirely with these crown stays, and we find them by far the most satisfactory arrangement of crown stays we have ever tried. When it becomes necessary to remove one or more of these stays for the purpose of straightening the sheet, we take them out in a few minutes, make the necessary repairs and replace the same bolts. Heretofore we have used sling stays in the four front rows, allowing some flexibility to accommodate the expansion of the flue sheet, but as these sling stays occupied so much of the space, we found it impossible to get at the crown sheet from the barrel of the boiler for the purpose of scraping off mud and scale which accumulates on the top of the sheet. To overcome this difficulty we have devised a flexible crown stay, as shown in Fig. 8. These flexible stays take the place of the four rows of sling stays, and we are now getting some locomotives built by the Baldwin Locomotive Works in which the four front rows, two back rows and two rows on either edge of the crown sheet are equipped with these flexible stays, Fig. 8, all the rest of the stays being of the rigid form, as shown in Fig. 9.

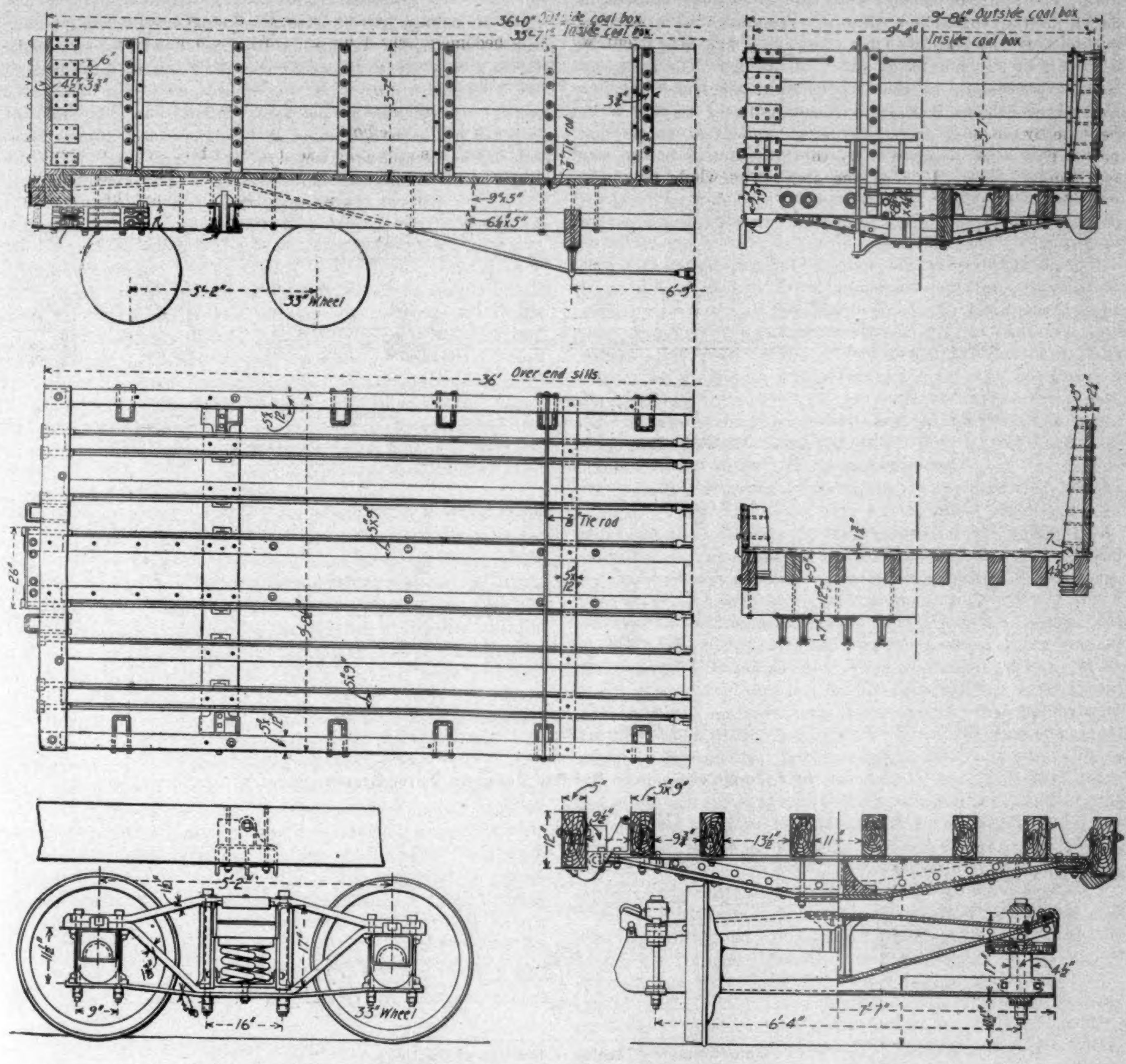
Referring to Fig. 8, it will be seen that we use a spacer formed of 1-inch gas pipe, a washer resting on the top of this spacer and a nut screwed down firmly on the top of the washer. This insures a proper fit between the button head of the crown stay and the under side of the crown sheet, but it will be seen by the construction of this crown stay that the sheet is free to expand upward, carrying the crown stays with it, as in the case of the sling stays, and when the boiler has become warmed up and the steam pressure has accumulated, the outer sheet expands and the washer seats itself on the shoulder provided in the bushing. This crown stay is also readily removed and renewed without having access to the inside of the boiler.

Figure 10 shows the radial stay which we propose to use in the construction of wide fireboxes. The principle is exactly the same as in Fig. 9, but we introduce the bushing, E, and form a steam joint with the copper washer between the cap nut, D, and the bushing, E. Figure 11 shows the style of cross stay that we have adopted. In trying to design a cross stay which could be readily removed and replaced without destroying the ends of the stay or the threads in the boiler plates when it becomes necessary to clean the crown sheet, we designed a number of different styles of these cross stays and submitted them to Mr. Vauclain of the Baldwin Locomotive Works, as we wished them introduced into the engines now being built by these works for this company, and upon the last suggestion by Mr. Vauclain we have now got it down to its present form and feel satisfied that it will answer all of the requirements. It will be seen that this cross stay can be taken out and replaced without removing the crown stays, or having access to the interior of the boiler.

The process of introducing this stay is as follows: First, screw in the bushing, F; second, screw the cross stay into the bushing, F; third, screw in the bushing, G; fourth, back off the cross stay until the collar is against the bushing, G; fifth, screw on the cap nuts, DD.

Two fireboxes, one a Belpaire, and the other wide, were designed so that a comparison could be made on the same class of engine and the cost obtained, with the view of introducing some of the wide fireboxes for trial on this road. These boilers give examples of the application of the crown stays above described. By referring to the wide firebox, Fig. 12, it will be seen that the four center rows of crown stays are exactly like Fig. 9, tapering copper washers being used under the cap nuts, and the other ten rows on either side of these four rows are provided with crown stays as shown in Fig. 10. With this arrangement we have a firebox practically equipped with flexible stays, and we may feel reasonably assured of having no reports of broken staybolts in boilers of this construction. The only rows of ordinary screw staybolts in the side sheets are down close to the mud ring. There is little probability of these giving trouble, due to the reduced amount of expansion in so short a distance, but should these staybolts and those in the throat sheet and back head give any trouble in service we would renew them with the flexible staybolts first described, and we would have a boiler with the firebox perfectly stayed and yet flexible in all directions. Such a firebox should not develop cracks as readily as with the ordinary system of staying; certainly we should feel no uneasiness as to the safety of this boiler, and in these days of high boiler pressure that is a very important consideration.

Mr. Edwin M. Herr has been appointed General Manager of the Westinghouse Air Brake Company. He has been Assistant General Manager since he left the Northern Pacific as Superintendent of Motive Power. He has instituted a number of extensive improvements in the manufacture of the air brake equipment and is engaged upon the application to the air brake business of the principles which made his success in railroad work. This is a pleasing recognition of his value, and the result will doubtless be to relieve Mr. H. H. Westinghouse, Vice-President, of many of the details of the affairs of the company. Mr. John F. Miller has been appointed Assistant Secretary.



36-Foot 80,000-Pound Coal Car with Siding Outside of the Stakes and Simplex Bolsters. Hocking Valley Railway.

36-FOOT 80,000-POUND COAL CARS.

Hocking Valley Railway.

S. S. Stiffey, Master Mechanic.

These cars are of wood, and are arranged to give large cubical capacity by placing the sideboards outside of the stakes. Their weight is 29,000 pounds.

In designing large capacity cars it is a problem to obtain sufficient cubical capacity without increasing the length more than is desirable or increasing the height of the sides to such an extent as to be inconvenient in loading and unloading. Therefore the construction here described undoubtedly offers several advantages.

In this design Mr. Stiffey was confined to a certain height and to the length of sills of the cars of 60,000 pounds capacity which were in use previously. To meet these conditions the number of longitudinal sills was increased from six to eight and large stakes were used, with sufficient width to extend a toe down against the inside face of the side sill. To prevent the side sills from rolling out under the strain which tends to bulge the sides of the car, two ⅞-inch tie rods are introduced nearly over the needle beams and across the car near the floor line, the effect of which is to tie the side sills together at the top.

The principal reason for introducing two additional sills was to prevent the floor from crushing down when hydraulic pressure is applied to the sides of the cars to clamp them to the rails during the operation of dumping on the Brown Hoisting and Conveying Machine Company's machine at the docks where the cars are placed in cradles and turned over bodily in unloading.

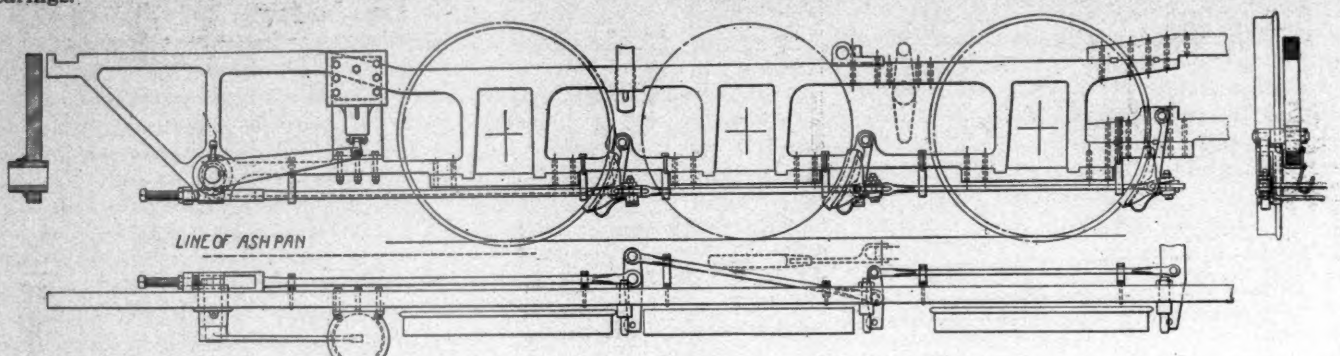
The length of the car over end sills is 36 feet, the width inside the box is 9 feet 4 inches, and the height of the sides is 3 feet 7 inches. By means of the arrangement illustrated the original capacity of the 60,000-pound cars, which was 870 cubic feet 1,242 cubic inches, has been increased to 1,191 cubic feet 792 cubic inches, these measurements being taken with the assumption that the cars are level full.

The truck which was designed for this car is also illustrated in the engravings. There are now 2,500 of these cars in service and Mr. Stiffey states that they have brought out many favorable communications from people interested in increasing the

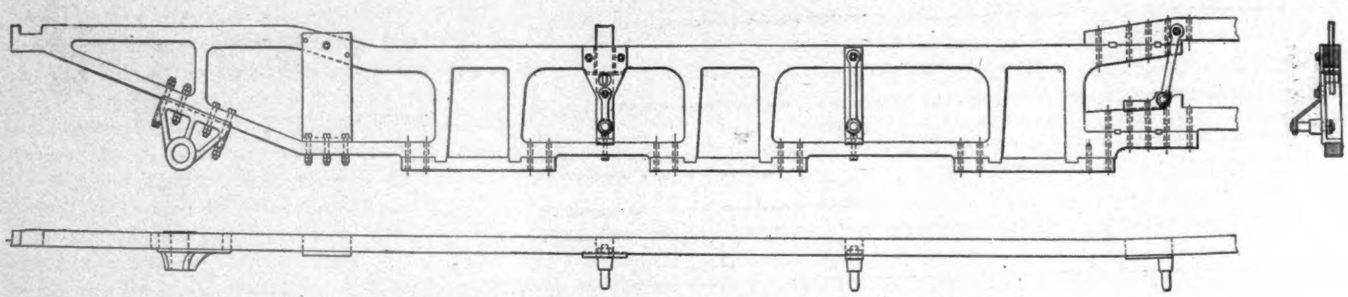
capacity of coal cars. These cars are equipped with steel bolsters. The Simplex bolsters were applied to 2,000 of them, as shown in the engravings, and the remainder have bolsters made by the Pressed Steel Car Company. The cars have the M. C. B. 5 by 9-inch axles and M. C. B. springs. The malleable castings were made by the Dayton Malleable Iron Company, including the Dayton malleable iron brake lever, Dayton brake wheel and the Hoey draft rigging. It should be stated that the bolsters were designed to carry the cars free of the side bearings.

A GREAT IMPROVEMENT IN DRIVER BRAKES.

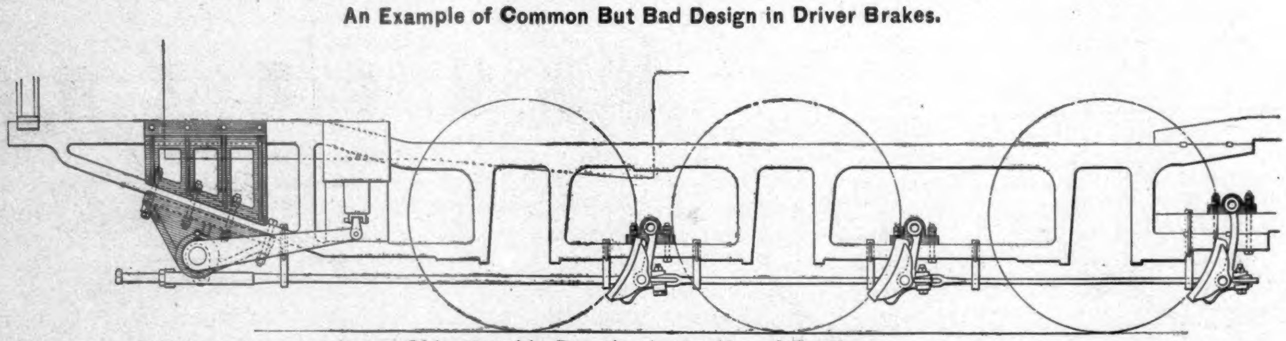
The clumsiness and unnecessary weight of the usual driving brake attachments to locomotives is shown in an almost startling way by a glance at a well designed arrangement, and it seems strange that the improvement was delayed so long. It surely was needed badly enough. In this case, the air brake has been considered, as it ought to be, as an integral part of the locomotive, which is to be provided for in the design of the details instead of putting it on as an attachment,



An Example of Good Design in Driver Brakes.



An Example of Common But Bad Design in Driver Brakes.



Objectionable Practice in the Use of Castings.

as if an afterthought upon the completion of the construction in other respects.

These engravings show two examples of very common practice contrasted with a new arrangement which does not involve any new principle except a complete provision for the attachment of the brake in the construction of the frames. The new plan was worked out by the American Brake Co., for new ten-wheel engines for the Chicago, Rock Island & Pacific. The old arrangement makes use of various castings and forgings of different shapes, and is attached by means of a large number of bolts with double nuts.

The hanger support between the middle and rear pairs of driving wheels is of special construction necessitated by the construction of the frame when a hanger link is required for the spring equalizer. It will be observed that in order to apply these plates to the frames, without requiring too large and objectionable bolts through the frames, hanger links are required throughout and the work is thereby greatly complicated and the number of bolts materially increased. Cross section views are shown which, together with the plan view, give a good idea of the complications which arise from the necessity of applying driver brakes to such frames.

Mr. R. H. Soule has resigned as Western representative of the Baldwin Locomotive Works at Chicago, to re-enter railway service. Mr. Soule was formerly Superintendent of Motive Power of the Norfolk & Western, and has been with the Baldwin Company since August, 1897. Mr. Soule is an ideal motive power officer and we shall congratulate the road which is fortunate enough to secure his services.

Mr. S. P. Bush has resigned as Superintendent of Motive Power of the Pennsylvania Lines, Southwest System, effective January 1, to accept the position of Superintendent of Motive Power of the Chicago, Milwaukee & St. Paul, which position was made vacant by the resignation of Mr. J. N. Barr, who went to the B. & O. Mr. Bush is but thirty-six years of age and is a graduate of Stevens Institute. He entered the service of the Pennsylvania in 1884 as special apprentice, and has worked his way up to the very important place he holds with the foremost motive power men of the country.

Mr. William Wright, General Foreman of the Vandalia at Terre Haute, has been appointed General Superintendent of the McKees Rocks plant of the Pressed Steel Car Co.

This adds an appreciable weight and places most of it very unfavorably, at the back ends of the frames. Now that so much study is given to the removal of unnecessary weight, the possibility of saving about 900 pounds, which is done by the new plan, should recommend it to locomotive men generally. This represents the weight which may be saved when the heavy fulcrum castings and cast frame braces are displaced by the light parts forged to the frames. The drawing of the old plan does not include the heaviest castings that are often used between the horizontal and inclined members of the frames. Furthermore, the new arrangement has the appearance of being designed instead of the apparatus being "thrown at the engine," as one motive power officer put it, on glancing at these drawings.

The Rock Island method employs fulcrums in bosses forged upon the frames, and it is clear that a great reduction in the number of parts is effected and at the same time there is a material gain in strength, and probably no increase in cost. The use of auxiliary bolts is avoided and the strength of the frames is not sacrificed by drilling large holes through them. The design is one which will recommend itself to all mechanical engineers entirely aside from the important consideration of weight. The advantages of these bosses are specially clear in connection with cast steel frames.

The fulcrum of the cylinder lever is made a part of the frame and is provided with a stiffening brace vertically over it between the two bars of the frame. This takes the place of the usual spacing casting which also supplies a bearing. It is not more difficult to make than the struts which are welded into the frames of heavy engines at the equalizers and once made in the frame it is permanent. This Rock Island engine has 110,000 pounds on the driving wheels and a braking force of 82,500 pounds, with 12x10-inch cylinders. The cylinders are placed with their axes vertical, which is one of the minor advantages gained. The merits of the improvement are so clearly seen in the drawing as to lead to the conclusion that it, or something similar, will become common practice. The engravings illustrating the usual practice represent the best of common practice, and it is safe to place the saving of weight, usually possible, at 1,000 pounds. The saving, however, is not in weight alone but in maintenance. This new plan is recommended by the American Brake Co. and is illustrated through the courtesy of the Westinghouse Air Brake Co. It is not entirely original, as the later engines of the Pennsylvania have excellent designs of driver brakes involving the principles here described.

ENGINEERING IN THE NAVY.

PRESIDENTIAL ADDRESS BY ADMIRAL GEORGE W. MELVILLE.

American Society of Mechanical Engineers.

The position and life work of Admiral Melville, Engineer-in-Chief of the United States Navy, promised an instructive and valuable address, and it was forceful, inspiring and satisfactory as showing the influence of the engineer in the high development and efficiency of our naval protection.

Every American was naturally proud of the fact that the first successful steam vessel was the work of an American engineer, but it was not so generally known that the same American, Fulton, designed the first steam war vessel of any navy. He referred to the "Demologos," intended for use in the War of 1812, but not completed until 1814, after the close of that conflict. The real beginning of naval engineering, however, was when the steamer "Fulton" was built in 1836 and in that year Mr. Charles H. Haswell, the "Nestor of engineering in this country," became the first chief engineer in our navy. The wonderful rapidity of naval engineering development was strikingly shown by reference to the fact that the first chief engineer was still alive, in full possession of his faculties and in the active practice of his profession to-day.

High tribute was paid to Isherwood, who had demonstrated the then unknown fact that under the conditions obtaining in the case of the U. S. S. "Michigan," with a slow-moving engine and low steam pressure, a ratio of expansion was soon reached, beyond which any increase would cause an absolute diminution of economy, instead of an increase, as would have been predicted from a strict adherence to Mariotte's law.

Among the other engineer contributors to naval progress was George Westinghouse. The wonderful achievements of Mr. Westinghouse, both as an inventor and as the creator of great industrial works, entitle him to be called the "Napoleon of industrial engineering." The high efficiency of the navy was due in a large degree to the competent engineers and to their excellent training at the Naval Academy, testimony to the high character of which was seen in the fact that the Government had been unable to retain the services of a large number of graduates who were called to take positions of responsibility in other fields of work. Many of these men were prominent members of this society. Not all the talent had departed, however, and the speaker made graceful acknowledgment of the support of his subordinates.

The most important steps in the improvement of marine machinery were reviewed, one of the most noteworthy of which was the decision to employ water-tube boilers exclusively for all classes of vessels. This conclusion was reached very recently, and the reasons are given elsewhere in this issue. They have an important bearing upon the future of naval construction. Steam pressures were gradually rising and present plans included the use of 250 pounds at the engines and some 25 or 50 pounds more than that at the boilers. While it was not believed that finality had been reached in the development of marine machinery, it was thought that the designer had little room in which to work with present types of engines except in the details. Rather guarded reference was made to the steam turbine. The performance of the "Turbinia" justified most careful study and further experiment, and it was encouraging to know that the steam turbine in this country was in the hands of so competent an experimenter as Mr. George Westinghouse, who is now engaged upon the construction of a unit of 2,000 horse power on a single shaft.

The war with Spain had shown the very great value of the repair ship, "Vulcan," and the distilling ships, as adjuncts of a fleet. The "Vulcan" carried the first cupola ever set up for operation on board ship, and this ship was the equal of anything, except a very large repair yard. She was an example on a large scale of taking the tool to the work instead of bringing the work to the tool. The distilling ship "Iris" actually furnished over 100,000 gallons of fresh water per diem. Her bunker capacity of 3,000 tons of coal gave her a potential capacity of distilled water of 60,000 tons, or as much as 12 of the largest "tankers." In the battle of Santiago the engineer stood out, a most prominent figure. The brilliancy of the victory was largely due to the skill and foresight of Chief Engineer Milligan of the "Oregon" in insisting that all of the boilers of that ship should be ready for action all the time, although others had steam on but half the boilers, and where it could be done half the engine power was laid off. This case was direct proof that, however admirable as a great fighting machine, the battleship is useless except in the hands of trained engineers. This led to reference to the recent change in the regulations whereby every future officer on our war vessels is to be trained as an engineer. If the new law was to be administered with regard to its plain intent, ours would be the most efficient navy in the world, but disastrous results would follow any indifference to the purpose of the law on the part of those in authority.

The whole tenor of the address was such as to inspire additional confidence in those who are responsible for this part of the nation's defences. It was particularly appropriate, as the speaker said, that one of the engineers of the old school should at the close of this chaper in the history of naval engineering give a review of some of its more important facts, and the manner in which it was done added to the high esteem in which Admiral Melville is held.

CORRESPONDENCE.

STAYBOLTS.

Editor American Engineer and Railroad Journal:

The whole secret, I believe, of the staybolt question is the larger water space. We have proved beyond any doubt that, by increasing the width of the water space, and consequently the length of staybolts, we have increased their period of usefulness about thirteen times without the slightest change in the material.

We are still drilling tell-tale holes in the ends of staybolts, and even on old boilers we drill them and afterward test them. In this way a great many partially broken staybolts are discovered.

We are not now putting in corrugated or cupped side sheets in our fireboxes, because we found that the cupped sheets had a life of but 18 to 20 months' service, and, while these sheets have lasted fully as long as straight sheets, we met with difficulty in patching them and found that this could not be done successfully, while with a straight sheet a portion may be cut out and replaced with a patch which is, of course, greatly in favor of the straight sheet.

In riveting up our mud rings we used to put the head of the rivet on the inside of the firebox. We now put the head on the outside of fireboxes, countersinking the sheet inside and driving the rivets up flush. There are several points in favor of this. The first is, that by getting rid of the head there is no obstruction whatever to putting up side grates. We used to have to chop out the side grates for the head. Another advantage is that the corrosive matter does not now stick on top of the heads and cause the sheets to rust out; also, by this method we have quicker work, as the rivet is hammered down flush. The riveting is done on the most important sheet in the firebox inside, where it is likely to give us less trouble from corrosion than if it were on the outside.

Chicago, Ill., Nov. 27, 1899.

ROBERT QUAYLE,
Superintendent Motive Power
Chicago & Northwestern Ry.

STAYBOLT PROGRESS.

Editor American Engineer and Railroad Journal:

The article in the American Engineer and Railroad Journal of December, under the above caption, was peculiarly interesting to the writer on account of some tolerably thorough investigations concerning staybolt practice made in the winter of 1892-93, the results of which were published in the proceedings of the Southern and Southwestern Railway Club for April, 1893. At that time these results, judging from subsequent correspondence and references, attracted considerable attention, but in seven years' time the report referred to has become ancient history and forgotten, the subject matter investigated all over again by others produces the same results and recommendations to be again forgotten. That the same thing has been going on for generations is plain from the fact that staybolts of the form recommended in the article referred to last month, and in the report of April, 1893, have been found in ancient locomotive boilers that were being cut up years ago. Some thoughtful men had investigated and reached the same results years before, the results to be lost and buried. Our text-books and treatises, our technical teachers, etc., are largely responsible for this.

The writer, being familiar with the rules and formulae, tests, government and Lloyd's rules, etc., was rather taken aback at one time when some staybolts were found broken in three pieces. The boilers in which these were observed were fitted with circulation sheets, and the stays referred to were found broken off at the outside sheet and again at the circulating sheet, through which they had been tapped. Here was an object lesson—the steam pressure and its strains had had nothing to do with the second fracture, as all strain on the stay was relieved when the first fracture occurred.

The next thing that came to the writer's attention in following up staybolt breakages was that bolts broken at the same places in boilers of the same classes and designs, when examined in place, or by marking their position before removal, showed that they had been broken off in the same way. For instance, the staybolts at the reverse bends in the sides of radial stay fireboxes near the middle always showed that vertical bending had broken them, because the line of final fracture, or "let go," was always horizontal. Similarly, in certain long fireboxes the end stays showed a vertical line of fracture, proving that horizontal bending had been their ruin. Different writers, who have touched on the subject of expansion of locomotive fireboxes, have considered the vertical movement of the box or lifting of the crown sheet, but I have yet to see the first mention of the longitudinal expansion as a factor in the staybolt breakages. In a deep, short firebox of the old style, between frames, the differences of longitudinal and lateral expansion are so small that no trouble to speak of comes from them, while the differences in vertical expansion are considerable. With modern shallow fireboxes, ten and eleven feet long, the opposite is the case, and it is the longitudinal expansion which does the most damage in many designs of boilers.

The writer well remembers the pride with which a prominent master mechanic some years ago pointed to a large boiler in the shop wherein all the portions of the firebox where broken stays were troublesome were strengthened by doubling the number of stays—placing them 2¼ inches centers—with the firm conviction that "now, by joining, we won't be worried any more with broken staybolts." The boilermaker and designer places stays, bolts, braces, etc., to make the boiler as rigid as possible, and ignores the destructive effect of the expansion and contraction; or, if he does anything to meet it, it is as above illustrated, to try and master it instead of providing for it intelligently. To attempt to overcome or master the expansion of a boiler due to heating is absurd, and, when indulged in, is really due to lack of appreciation of the irresistible power to be contended with.

Experiments made in England with cylindrical, corrugated fireboxes, showed that, to shorten a "Fox" corrugated firebox 30 inches diameter, one thirty-second of an inch required a pressure of over 300 tons. What would be the power exerted by a flat firebox sheet 10 feet long, well held to its place, and prevented from buckling by numerous staybolts, when due to, say, 1/16 inch of scale, it must expand, say, 1/32 inch in length more than the outer shell? The power is there and is inevitably absorbed by crushing the sheet or breaking the stays; then, when the cooling off process comes, the sheet having been previously shortened, is stretched again. Leaky seams and cracked and pocketed side sheets are the inevitable result.

Inquiry made in 1892 from 22 prominent and progressive railroads brought out the fact that on some roads staybolts had to be tested every week, the renewals being a heavy source of expense and delay to the engines; while on other roads broken staybolts were rare, it being found sufficient to test them once a year. Why the difference? The trouble from broken stays was found to be directly proportionate to the amount of scale forming matter in the water. Where the firebox sheets became rapidly incrusted, so that the inner sheet would be many degrees hotter than the outer shell, there the broken stay and cracked sheet and leaky flue were household words. Where the water was soft and good, so that little or no deposit ever formed on the sheets, both sheets could heat up and cool down together, broken stays and cracked sheets were rarities, and staybolts only had to be tested once a year. It is the repeated bending that breaks the staybolts, assisted of course, by the strain.

A wire rope, if the ends could be secured steam -tight in the sheets, would make an ideal staybolt.

But flexibility in the staybolts is only half the battle. The firebox sheets must expand and contract in all directions more rapidly than the shell sheets; this expansion and contraction should be considered in the design of the boiler at every brace and stay rod, at every seam and corner of the firebox, giving easy curves and bends at all the corners with room for the boiler to breathe vertically, horizontally and laterally. The recently illustrated boiler with a single large corrugated, cylindrical firebox, seems to offer a remedy for all these ills, if it does not introduce other evils of perhaps a worse nature. A few years' hard service for such boilers in districts where the water bears scale and boilers have to be worked to their utmost will bring the answer.

Roanoke, Va., December 16, 1899.

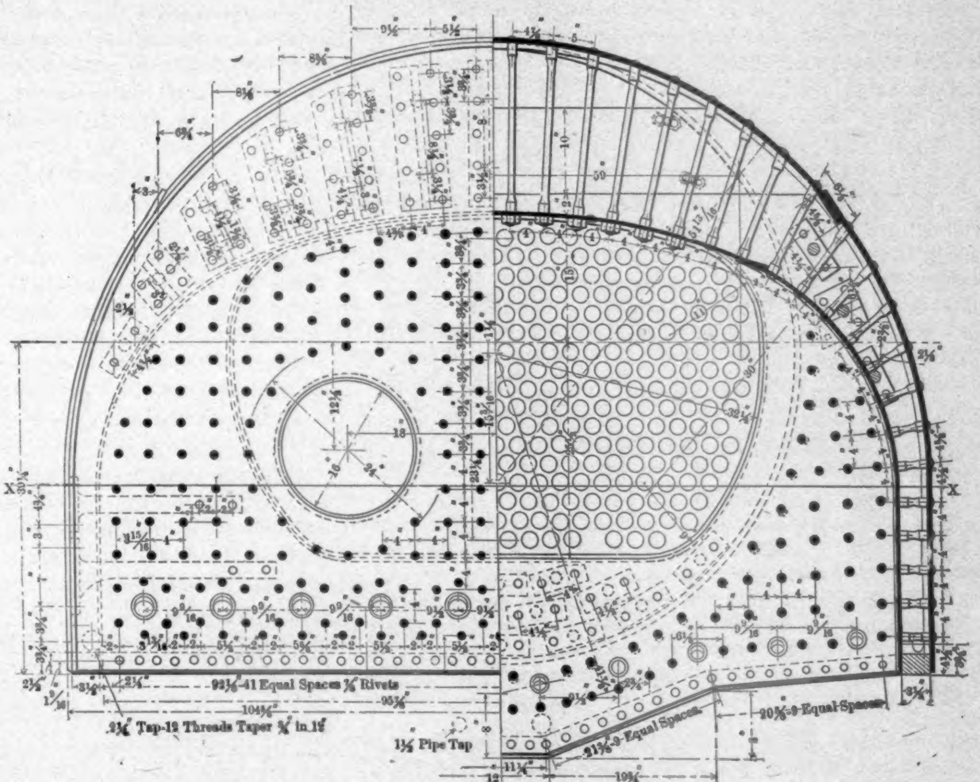
R. P. C. SANDERSON,
Master Mechanic,
Norfolk Western Ry.

STAYBOLT PROGRESS.

Editor American Engineer and Railroad Journal:

I have read with great interest the article on Staybolt Progress in the December issue of your paper, as I have been investigating this matter for some time. While, in a general way, my results coincide with those given, my observations lead me to somewhat different conclusions in some instances. Service tests are undoubtedly the most satisfactory for determining the values of different iron, but they require a long time, in fact, years, to obtain results. In the meantime, the particular brands tested may go out of the market, one instance of this kind happening recently. Vibration, or other tests that will give uniform results under conditions approximating service conditions, offer the best means of solving the many mooted questions arising from the use of staybolts. As stated in the concluding paragraph of the article referred to, the present form of vibration test is not satisfactory, as the results vary too widely; on the other hand, with even the extremes of variation, they point conclusively to certain deductions, which are of great value, and the improvement of apparatus and methods will soon evolve something more satisfactory now that the value of such tests is becoming widely recognized.

The length of staybolt is a decided factor, and, where possible, the water spaces should be made large. There are limits, however, to this increase. On most large roads, nowadays, there is a demand for heavy engines capable of pulling a given tonnage on certain runs. The strengthening of bridges has not kept pace with the demand for the heavier engines, so that in designing such engines every superfluous pound of weight must be dispensed with. The increasing of water spaces runs up weight very rapidly, especially on wide firebox engines. Another limiting factor is due to the steaming properties. Of two engines otherwise similar, that having the less water space can furnish the most steam when forced. Under no consideration should they be less than 3½ inches, and as much wider as above limits allow.



Wide Firebox with Semi-Circular Outside Shell.

The form of boiler is almost as important as the length, as regards the life of staybolts. All reverse curves, curves of short radii, and variations in contour between the outer and inner sheets should be avoided. Among the many advantages of the wide firebox extending over the wheels is the entire elimination of these factors. The outline illustrated in a former article shows the first step toward doing away with short bends and dissimilar contours, the outline being composed of a series of tangent curves. The enclosed drawing shows the next step. Above line X—X, the outer shell is a true semi-circle, and is an improvement, in that it is self-contained. The inner sheet opens the water leg gradually, and follows the contour of the outer sheet closely. Our experience has proved this design to be a saver of staybolts.

The records of vibration tests show some results hard to account for. Six different shapes of staybolt were tested, with the following results as regards ultimate life, the order indicating the relative standing:

1. C. B. & Q. form, with drilled tell-tale hole.
2. Bolt threaded entire length; drilled tell-tale hole.
3. C. B. & Q. form, punched tell-tale hole.
4. C. B. & Q. form, no tell-tale hole.
5. Threads stripped between sheets; no hole.
6. Upset head from ¾ inch to 1 inch; no hole.

The special form of bolt as used by C. B. & Q., when having a drilled tell-tale hole, was undoubtedly the best. Whether the additional cost covers the occasional removal of broken bolts is problematical. While the tests were not altogether satisfactory, on account of variations, they indicate pretty clearly that drilling adds life, punching is better than no hole, and upsetting is bad. It is questionable if the all-threaded bolt is any better than the one stripped between sheets. However, it is equally as good and there is reason to justify such a belief. When preparing bolts in large quantities, it is impossible to strip the threads right up to the sheets, as it would require an almost infinite number of lengths. As almost all bolts break close to the outside sheet, and even a thread inside sometimes, the stripping of thread in the center leaves the bolt no more flexible or no weaker at the stripped portion than elsewhere, consequently there seems little to be gained by this practice.

A B C D E F G H

Riveting of heads, in my estimation, is the largest factor. Two similar bolts headed by the same man vary in the testing machine in proportion to the amount of abuse they received in being headed. The reason assigned for the United States Government method giving superior results, seems to be the reverse of the statement you make. In testing the hand-headed bolts, those that were driven hardest broke first. The riveting crystallizing the harder irons and making it more dense and a tighter fit in the sheets, the result being that,

when firmly held by the entire thickness of the sheet, the stress was concentrated at the inner side of the sheet. When loosely driven, so as to allow movement in the plate, it was found almost impossible to break them. The United States Government method of heading confines the injury to the metal, to that part outside of the sheet, or at least prevents it from extending through the sheet, as in hand riveting. Not being held so rigidly in the sheet, the stress due to vibration is distributed somewhat, and this, with the greater flexibility from the same source, greatly prolongs the life of the bolts.

The strains on a staybolt that are most destructive are those due to the difference in expansion and contraction of the inner and outer sheets. From the nature of these strains, a staybolt is similar to a cantilever, having a concentrated load applied repeatedly at the end, removed, and the direction of application reversed. On staybolts of uniform section the maximum stress is located, therefore, at the outer edge of support—in this case the outer shell. Consequently, the less rigid the support, due either to thin sheets, heading as above, or both, the greater the life, as these conditions may allow the entire movement to take place without inducing a fibre stress equal to the elastic limit of the material in the staybolt. Theoretically, it would seem that the use of thin outer sheets is justified. Practical considerations, however, indicate the questionability of this. With thin outer sheets, which may have plenty of strength, there is, on the other hand, very little margin left for corrosion and kindred evils that determine the life of the boiler. For this reason it seems preferable to renew a few bolts occasionally and add to the life of the sheet by making it a little heavier than considerations affecting the staybolts only demand. Unless it is necessary to sacrifice strength and life to weight, ½ inch would appear to be the minimum thickness for the outer sheet, and, on the other hand, it is not advisable to increase this very much, as, starting with ½ inch as a minimum, we may, along with the life of the sheet, consider the effect of increased thickness on the staybolts. As regards the fire sheet, the average practice seems to be to make the side sheets 5/16 inch thick and the crown sheet ⅜ inch thick, up to and including 180 pounds pressure. Above 180 pounds the side sheets are also made ⅜ inch thick.

Further results of investigation are confirmed by the article in question, as regards piling. The enclosed tracing shows the piling of several irons tested. A, B, C and E showed little variation as the result of changing direction of vibration; while D, F, G and H were very strong with the piling and weak against it. As they are no stronger than in the weakest direction, they are inferior to the former sections.

That the best iron should be used regardless of first cost is indisputable, but that the best iron does cost the most is another story.

Extremely hard refined irons do not appear to give as good results as softer irons. When removing bolts of hard, fine iron, I have seen one blow cause the head to fly off and strike the wall. The fracture had the fine crystalline appearance of tool steel. The hard irons—and the amount of hardness depends on the amount of refinement, largely—seem to crystallize in heading, and the results of this injury extend much farther than with softer irons. The effect of heading, as regards the fit in the sheet, seems to show that in soft irons it is local and does not extend through the sheet, leaving them more flexible. It appears, then, that the ideal iron is one which, from the method of piling, stands an equal number of vibrations in all directions, and is soft enough to prevent crystallization and rigid fit in the sheets due to the heading.

South Easton, Pa., Dec. 9, 1899.

F. F. GAINES,
Mechanical Engineer,
Lehigh Valley R. R.

HIGH SPEEDS OF THE NEW LAKE SHORE PASSENGER LOCOMOTIVES.

Satisfactory running is reported by the Brooks Locomotive Works for the 10-wheel passenger locomotives for the Lake Shore & Michigan Southern, illustrated in our November issue. These engines were designed for hauling heavy trains at high speeds, the chief object being not so much for excessively fast running as for reserve power to handle unusually heavy trains at the highest schedule speeds. The beginning has been made, as is shown by the record of the fast mail train between Buffalo and Cleveland, November 22, 1899.

This train, No. 3, was made up of engine 601, one of the class illustrated in our November issue, four postal cars, two sleepers, one combination car and one coach, or eight cars in all, the weight of which is estimated at 300 tons, exclusive of the engine. The table gives the stations, the time and the distances. It should be noted that the time between stations does not give the seconds. This, in short distances, would influence the speeds in miles per hour materially, and the figures of significance are the times for the long distances. The times between West Seneca tower and Collinwood, taken with the arrivals and departures at Dunkirk, Erie and Ashtabula, give a fair idea of the run. The time from West Seneca to Collinwood is mentioned specially because the runs from Buffalo to West Seneca and from Collinwood to Cleveland are slow on account of the yards between these points. The speed between West Seneca and Collinwood, deducting stops, is 61.17 miles per hour, and this tells the whole story. The speed, including stops, was 56.13 miles per hour, and the average speed for the entire run of 181.92 miles was 52.98 miles per hour. The distance from Dunkirk to Cleveland, 143 miles, was made in 144 minutes. There are three stops for water in this run, also two crossing stops, making five stops in all, which occupied an aggregate of 16 minutes.

This train is scheduled to leave Buffalo at 6.25 P. M. (central time) and to reach Cleveland at 10.50 P. M. On this occasion it was 59 minutes late in leaving Buffalo and yet arrived in Cleveland on the schedule. It would be interesting to know the boiler pressures during this remarkable run, but we are informed that the limit of power was not reached, which is equivalent to saying that the boiler capacity was not severely taxed. During the entire run a strong side wind was blowing, making the work more difficult.

The Brooks Locomotive Works furnished eleven of these magnificent engines, and our readers have already been informed as to their details. The record of the run is appended.

Stations.	Time Depart. P. M.	Time Arrive.	Distance.
Buffalo	7.24	....	....
Buffalo Creek	7.31	....	....
West Seneca Tower	7.35	....	4.36
Athol Springs	7.39	....	4.87
Lake View	7.44	....	5.18
Angola	7.51	....	7.05
Farnham	7.55	....	4.11
Silver Creek	7.59	....	5.82
Dunkirk	8.15	8.10	8.84
VanBuren	8.21	....	4.00
Brocton Junction	8.26	....	4.79
Westfield	8.34	....	8.05
Ripley	8.42	....	7.88
North East	8.50	....	7.66
Harbor Creek	8.56	....	6.51
Erie	9.07	9.03	7.45
Dock. Junction	9.13	....	....
Swanville	9.19	....	8.24
Girard	9.25	....	7.08
Springfield	9.29	....	4.63
Conneaut	9.35	....	7.64
Tower No. 2	9.40	....	....
Kingsville	9.43	....	7.41
Ashtabula	9.53	9.48	5.82
Coal Chutes	9.57	....	....
Geneva	10.03	....	9.34
Madison	10.08	....	5.42
Perry	10.13	....	4.99
Painesville	10.18	....	5.73
Mentor	10.23	....	6.16
Willoughby	10.27	....	4.34
Wickliffe	10.31	....	4.33
Nottingham	10.35	....	4.57
Collinwood	10.37	....	2.04
Glenville	10.39	....	1.95
Cleveland	10.50	....	5.33

	Miles per hour.
West Seneca to Collinwood, including stops	56.13
West Seneca to Collinwood, not including stops	61.17
Erie to Collinwood, not including stops	61.95
Erie to Collinwood, including stops	58.51
Erie to Cleveland, including stops	55.37
Erie to Cleveland, not including stops	58.19
Speed, including stop at Dunkirk	53.18
Speed, West Seneca to Erie, including stop at Dunkirk	56.14
Speed, West Seneca to Erie, not including stop at Erie	59.64
Average speed to Erie, not including stop at Dunkirk	56.04
Average speed in 181.92 miles	52.98

THE DEVELOPMENT OF THE STEEL CAR.

The large number of steel cars now in service and the crowded condition of the plant of the Pressed Steel Car Company are evidences of a sudden and remarkable revolution in car construction which may be profitably reviewed.

There are now in service in this country nearly 20,000 steel cars, and the capacity of the works of the Pressed Steel Car Company is now 75 cars of 40 to 50 tons capacity per day, and this will soon be increased to 100 cars per day. With the orders now on hand, and with continued prosperity for the railroads, it is probable that during the year 1900 30,000 steel cars will be built, and at the end of that year there will be 50,000 steel cars of large capacity in service on American railroads.

It is instructive to notice how a question which has occupied the serious attention of the Master Car Builders' Association for a number of years and finally given up as a hopeless task will settle itself by commercial and economic pressure and by the effort of individual genius outside the Association. In June, 1896, a committee of that Association made a report on steel cars which dealt with the necessity for standard sizes for steel cars, not only in general dimensions, but in the size of the rolled sections, it being taken for granted that the future car would be made of rolled beams, channels and angles. The economical side of the question was also discussed and the important fact that steel cars would have a larger ratio of carrying capacity to light weight than wooden ones was pointed out. It was shown that 50 per cent. of the cost of freight car repairs was for wheels, axles, bearings, brake shoes and other similar parts which will wear out as rapidly under the most perfect steel car as under the present design of wooden car, and that the steel car body must produce increased earnings and cost enough less for repairs to pay for the interest and depreciation of its extra first cost.

The 1896 Master Car Builders' Association report included a design for a steel hopper car made for the Carnegie Steel Company. The capacity being 100,000 pounds and light weight 39,950 pounds, a sample car of this kind was exhibited at the 1896 convention, and this was, doubtless, the real beginning of the 50-ton hopper car industry, and the prototype of the pressed steel hopper car which was designed by the Schoen Company, and appeared at the convention in 1897. The action of the association on the 1896 report was the appointment of a committee of five to present individual designs. The report of this committee in June, 1897, again emphasized the importance of standard general dimensions, and stated that the great majority of motive power officers were not prepared to consider a car of greater capacity than 30 tons for general interchange service. Three members of the committee presented plans for steel box and flat cars, and exhibited three sample cars, with steel under-frames. The Schoen Pressed Steel Company exhibited two pressed steel 50-ton hopper cars. The committee was discharged and a new one appointed to criticise the plans already submitted, and here the work of the Master Car Builders' Association on this subject virtually closed. In 1898 the new committee reported that it did not have sufficient information in detail to make exact and complete calculations of the strength of the cars, designed by members of the previous committee. Acting under the impression that its principal business was to recommend a standard steel car, the 1898 committee reported that it was impossible to design a car which would meet with universal favor and the limited experience with steel cars was a sufficient reason for not selecting a design at that time. The report was accompanied by plans of the Schoen 50-ton hopper car. The committee was discharged and at the convention of 1899 no report on steel cars was made and no committee appointed.

In 1897 the Schoen Company received their first large order for steel cars, and built 600 pressed steel cars of the double-hopper gondola type, 50-tons capacity, for the Pittsburg, Bessemer & Lake Erie R. R. In that year they also built several hundred somewhat similar cars for the Penna. R. R. In 1898 the Schoen Company and the Fox Company were combined, forming the Pressed Steel Car Company. The business has rapidly grown to its present enormous proportions, which will soon have a capacity of 100 large steel cars per day.

The cars for eastern roads have been largely 50-ton coal cars with inclined self-dumping floors, the anthracite coal trade having developed coal wharves suitable for hopper cars. In the west, however, the preference seems to be for a gondola car with a horizontal floor, flat drop bottom doors, and a capacity of 40 tons. Quite a number of these fine-looking cars are now running on western roads. Several years ago the Fox Company built a few coal cars with steel under-frames and a wooden box, and this idea is again coming to the front, and a large order has been given for cars of this type. In the Master Car Builders' Association reports on the subject (1896 and 1897) illustrations were given of box cars with a steel under-frame and a wooden box, the capacity being 60,000 pounds. A number of roads now find it desirable to build box cars having a capacity of 40 tons, and this large capacity immediately suggests the advantage of a steel under-frame. We understand that the construction of a large number of 40-ton box cars with steel under-frames and wooden superstructure is now under consideration. The necessity for cars of large capacity for general interchange service, in which box cars make their largest mileage, has not been felt heretofore, and they are not likely to show such superior economy as the large capacity coal cars in local and special service. But the mixture of heavily loaded steel cars with wooden box cars in through freight trains is causing such frequent failures of wooden cars, that a new and strong argument for steel under-frames for box cars is rapidly making itself felt. Large numbers of wooden cars are being sent to the shops for repairs, and numerous wrecks are caused by the failure of old wooden cars, when forming parts of trains of big steel cars. The weak cars are either pulled apart or crushed by the application of the air brake. It may be fortunate that the life of the old cars is thus shortened, and it is an advantage to have them out of the way. The draft-rigging on old wooden cars is so poor that trains are broken in two, and it is not possible with such weak links in the chain to utilize the full tractive power of large locomotives. This evil exists to such an extent that it has been necessary to issue general orders on several large roads to reduce the train loads, and the old wooden car is therefore at present the regulating element in determining the maximum train-load. Strange to say, it is not the power of the engine or the car capacity nor the car lading (all of which have been pushed almost to the extreme limit) which are to be principally considered in tonnage rating, but the very uncertain and troublesome feature of a poor draft-rigging on an old wooden car. This also, we believe, will in the future be one of the principal reasons for building steel under-frames for all classes of freight cars.

The steel car in service is not entirely free from troublesome features. Car inspectors say that when the couplers fail on these cars they are difficult to replace without sending them to the shops, and it is frequently necessary to chain steel cars together, and this is always a dangerous expedient. Another trouble with steel cars arises from the drop door fastening working loose and permitting the load to dump out on the track. Recently several steel hopper cars dropped their doors and lading while in motion, and after the train was stopped hydraulic jacks were necessary to force the doors, with their load, back into position.

The shop repairs of steel cars will soon require a new kind of a car shop, more like a boiler or bridge shop, with metal working tools, such as punches, shears and riveters. It will also require a new kind of repair man, who instead of being a carpenter must be a metal worker. The shops, tools, and men will soon adjust themselves to the new order of things and provision for steel car repairs must be made a prominent feature of new car shops.

Consolidation Freight Locomotive—Illinois Central R. R.

WM. RENSHAW, *Superintendent of Motive Power.* ROGERS LOCOMOTIVE WORKS, *Builders.*

HEAVY CONSOLIDATION LOCOMOTIVE.

Illinois Central Railroad.

Built by the Rogers Locomotive Company.

Another heavy locomotive has been added to the remarkable list for the past year. This one is for regular road service on the Illinois Central. It was completed last month and is reported to be doing satisfactory work. This engine is lighter than that of the 12-wheel type recently furnished the same road by the Brooks Locomotive Works, and illustrated in our issue of October, 1899, page 316. That only one of each of these heavy types was built seems to indicate hesitation to go too fast into heavy engines.

The design illustrated is among the heaviest of the consolidation type. There are two heavier, however, viz., the Pittsburg, Union Railway Consolidation (issue of November, 1898, page 365), and the Baldwin Vauclain Compounds for the Lehigh Valley (issue of December, 1898, page 395).

This engine will run on one of the divisions south of the Ohio River and was intended to be powerful enough to haul trains of 2,000 tons over 38-ft. grades. The tractive power at 85 per cent. of boiler pressure is very nearly 50,000 pounds. The heating surface is not large for such a total weight, in fact, the heating surface is but 286 square feet more than that of the new 10-wheel passenger locomotives of the "Lake Shore," and it is 146 square feet less than that of the new Delaware & Hudson consolidation engines described in our December, 1899, issue. It is perhaps not perfectly fair to compare locomotives on a basis of power by stating their relative heating surfaces and weights on driving wheels, but as the hauling power is determined by the weight upon drivers and as the sustained boiler power depends very largely upon the heating surface, the following figures will be interesting, and they are fair when comparing the consolidation engines with each other.

	Union Ry. Consol. Pittsburg.	I. C. R.R. Consol, Rogers.	I. C. R.R. 12-wheel. Brooks.	D. & H. Co. Consol. Schenectady.	L. V. Consol. Baldwin	L. S. & M. S. 10-wheel Passenger Brooks.
Weight on drivers in lbs.	208,000	198,000	193,200	157,500	202,232	133,000
Total heating surface....	3,322	3,203	3,500	3,349	4,103	2,917
Lbs. on drivers per sq. ft. divided by heating surface	63	61.2	55	47	49	45.5

The Lehigh Valley and the Delaware & Hudson engines have wide fireboxes and are out of the narrow firebox class, but they are included in order to show the results of efforts to make the weights count in the boiler capacity. It is exceedingly interesting to see the standing of the new Brooks fast passenger locomotives for the Lake Shore in this respect. The question here indicated is, what is the value of the ratio between boiler power and the limiting weight? Different designers certainly have very different ideas and this seems to be a most excellent argument for an elaborate test to show whether it is worth while to get this ratio down on heavy engines.

The boiler is very large, the diameter being 80 inches at the front course. The firebox is unusually large, the grate being 11 feet long and the grate area 38.5 square feet. This is believed to be the largest grate ever used for a narrow firebox engine. The firebox is above the frames, and the mud ring is wider than the frames, giving a width of 42 inches to the grate. The boiler is of the Belpaire type with two rows of sling-stays in front. The steam pressure is 210 pounds per square inch. The center of the boiler is 9 feet 2 inches above the rails, the top of the stack is15 feet and the crown sheet is 10 feet 6 inches above the top of the rail at the flue sheet. With such a large and heavy boiler we should expect the center of gravity of the locomotive to be very high, but Mr. Reuben Wells, Superintendent of the building company, states that it was located by experiment at a point 50½ inches above the rails. We shall print an account of how this was found.

We illustrate a few of the details of this engine, but there are interesting features in those that are omitted. The cylinders are 23 by 30 inches. The pistons are of cast steel and only 7/16 inch thick in the plates. The piston rods are extended, the forward portion passing through a sleeve 8 inches long, but without a stuffing box. The crosshead looks small for such surroundings, but it has a bearing of 8 by 24 inches and is amply strong. The top and bottom slippers are removable, each in one piece. The cast-steel driving boxes, shown in Fig. 7, are also strong and light, the driving journals are 9 by 12 inches, which would necessitate an exceedingly heavy box if made of iron. It has dove-tailed grooves for babbitt strips to bear against the hubs of the driving wheels, which are also of cast steel. In an engine of this size it is possible to obtain a thrust of as much as 42 tons alternating from one side to the other of the engine and changing in direction at every stroke. That is what a 23-inch cylinder gives with a steam pressure of 200 pounds per square inch, which will probably be imposed upon these pistons at slow speeds. This has been provided for by a steel plate casting bolted to the back of the cylinder saddle and very securely bolted to the frames. This casting is nearly five

feet long and is intended to aid in holding the enormous stresses referred to and to take some of the twisting strains.

Figure 2 shows the general arrangement of the engine, the draft appliances and the driving spring rigging. Figure 4 shows the arrangement of the valve connection to enable it to pass the second driving axle. The yoke is of cast steel and its weight is carried by the link, D, of Figure 5, which is supported to a cross-brace of the frame by the bracket, F. In Figure 4 the back end of the yoke is seen to be double. The pin, H, passes through both portions and also through the link block. The link is provided for in tne space, O, of this engraving. This permits it to come very close to the axle. The yoke is closed at the bottom of the thimble, G, through which a bolt passes as indicated.

The link and hanger are shown in Figure 6. The hanger is double with a connection across the parts, the link has a face

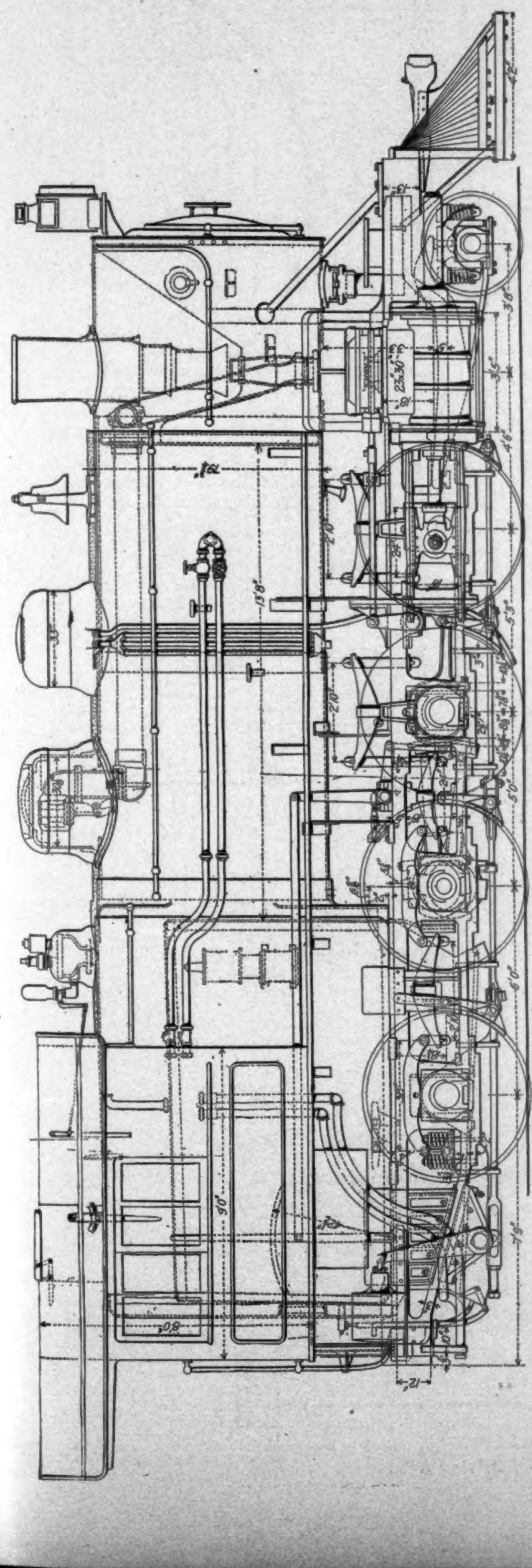
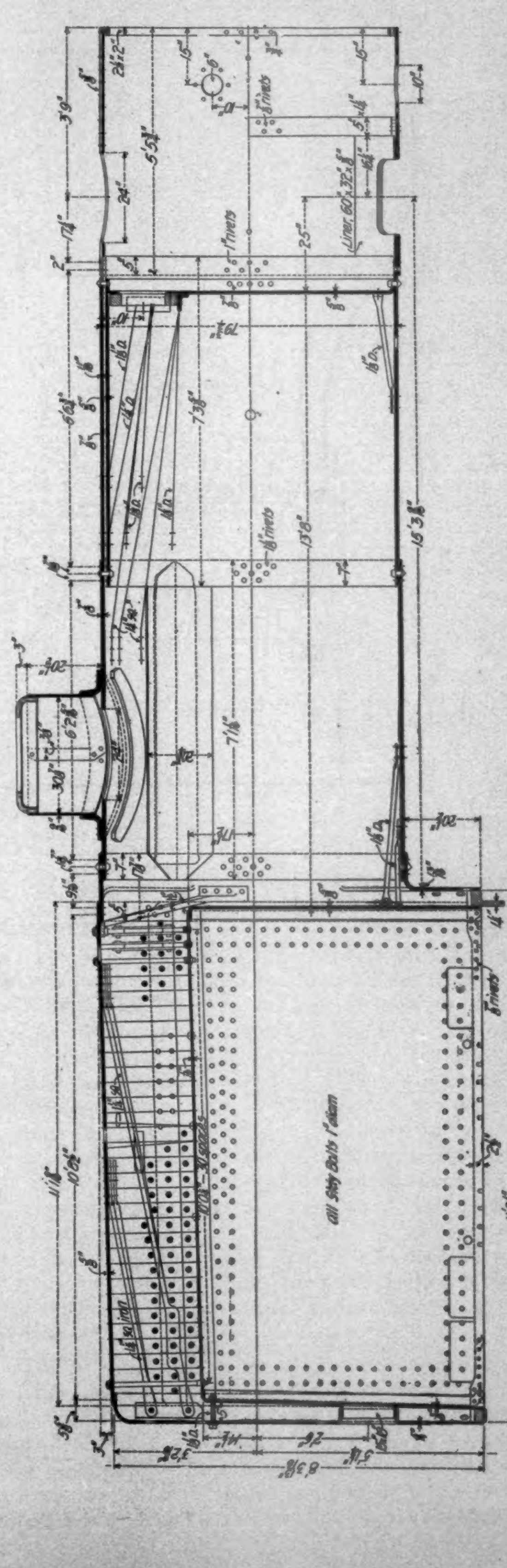


Fig. 2.—Side Elevation.



Longitudinal Section of Boiler.

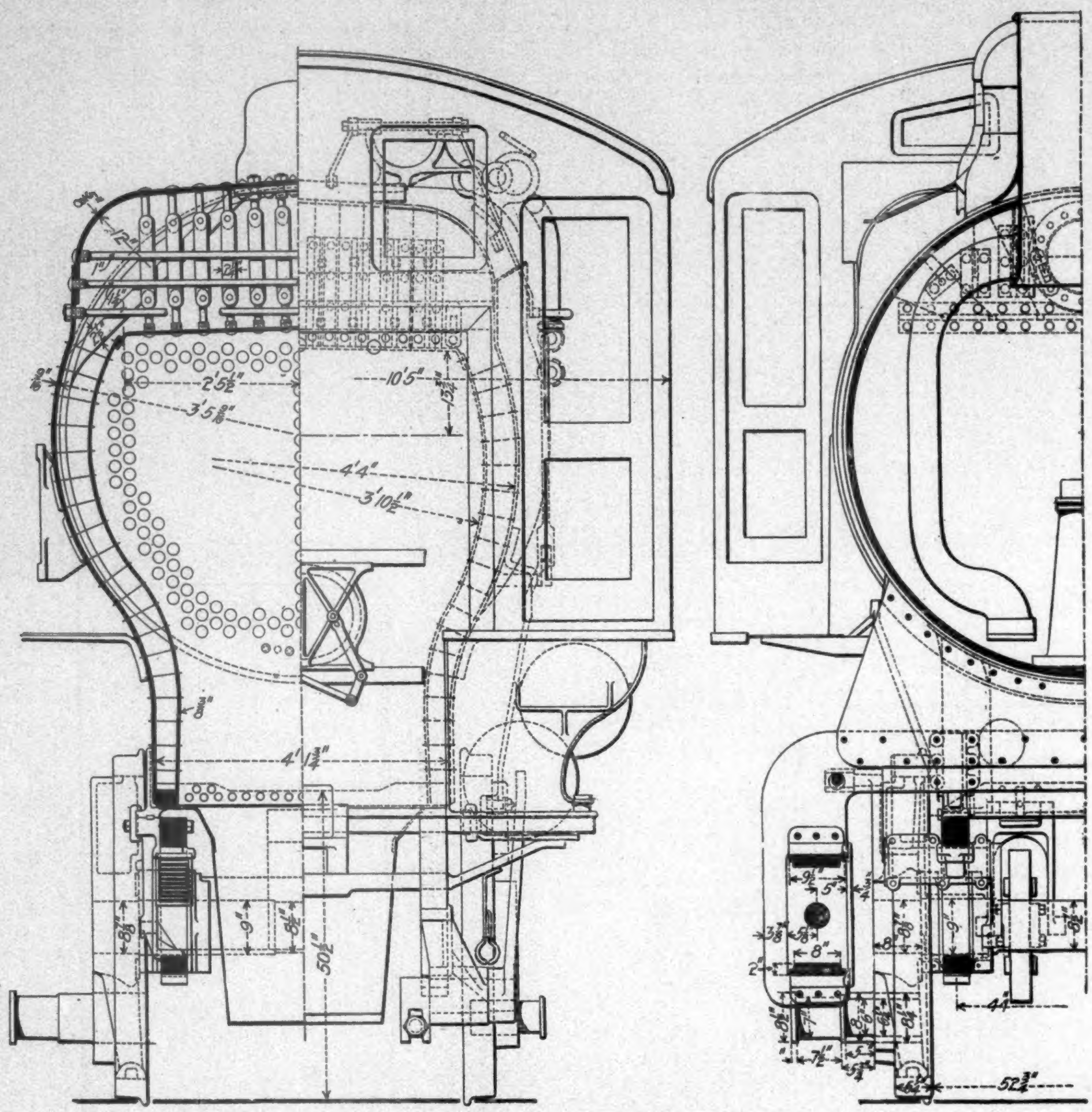


Fig. 3.—Half Sections and End Elevations.

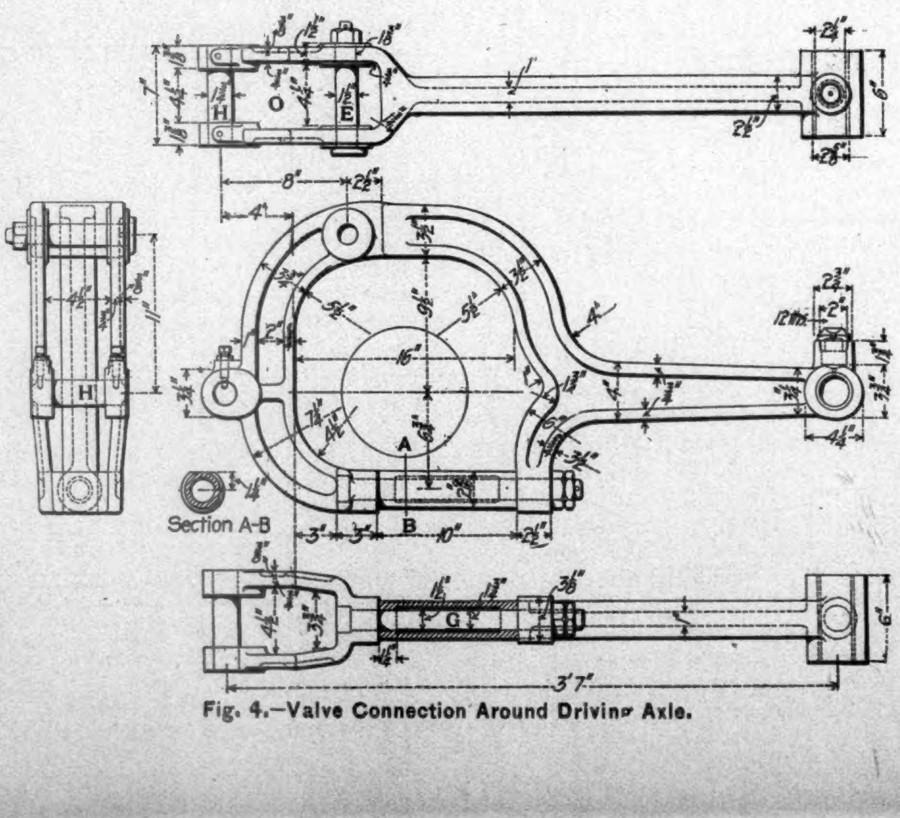


Fig. 4.—Valve Connection Around Driving Axle.

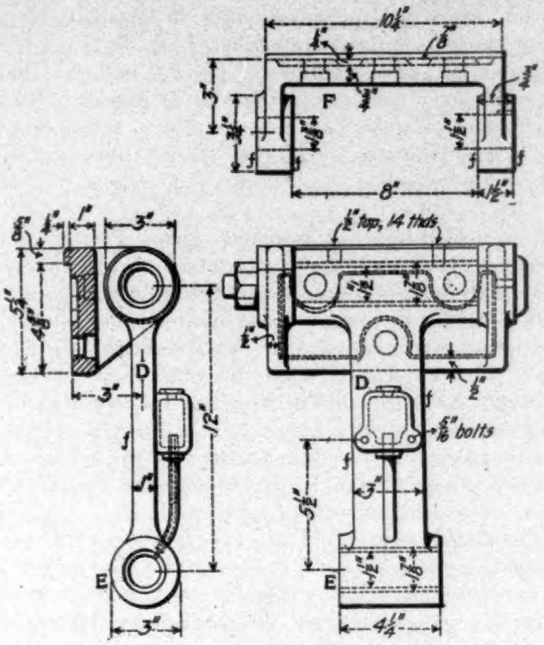


Fig. 5.—Support for Valve Connection.

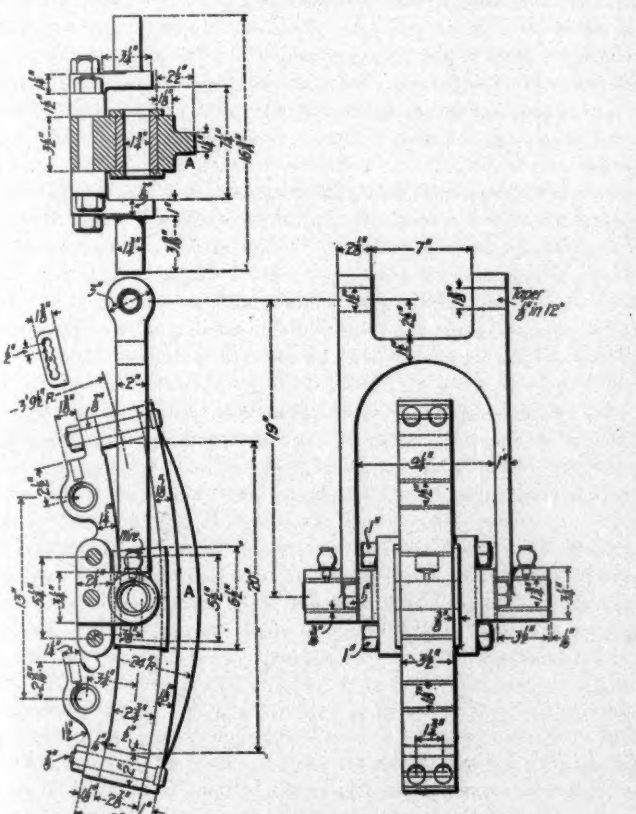


Fig. 6.—Link and Link Hanger.

of 3½ inches. The saddle is in two parts and is secured to the back of the link. The link is stiffened by the rib, A, which is a good plan for working valves as large as these.

The following table gives the chief characteristics of the engine:

Cylinders	23 by 30 in.
Total weight in working order	216,000 lbs.
Weight on drivers	196,000 lbs.
Weight on truck	20,000 lbs
Driving wheels, diameter	57-in.
Driving wheel centers	50-in.
Driving journals	9 by 12 in.
Driving wheel base	16 ft. 3 in.
Total wheel base	24 ft. 5 in.
Boiler type	Belpaire
Boiler pressure	210 lbs.
Boiler diameter in front	80 in.
Boiler, height of center above rail	9 ft. 2 in.

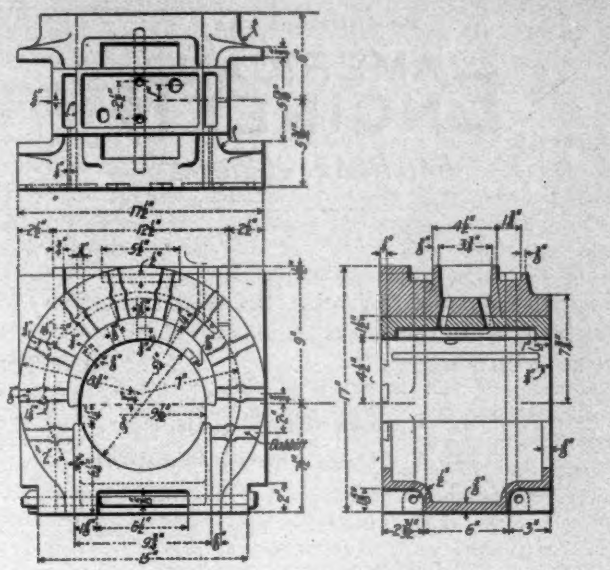


Fig. 7.—Cast Steel Driving Box.

Heating surface, firebox	252 sq. ft.
Heating surface, tubes	2,951 sq. ft.
Heating surface, total	3,203 sq. ft.
Grate area	38.5 sq. ft.
Firebox, inside	132 by 42 in.
Firebox, height front	78 in.
Firebox, height back	75 in.
Tubes, number	417
Tubes, diameter	2 in.
Tubes, length	13 ft. 8 in.
Thickness of sheets in boiler	⅞ and ⅝ in.
Thickness of crown sheet	7/16 in.
Thickness of firebox, sides and back	⅜ in.
Thickness of firebox tube sheet	⅝ in.
Slide valves	Allen-American
Slide valves, travel of	6 in.
Steam ports	1 5/16 by 23 in.
Exhaust ports	3¾ by 23 in.
Bridges, width of	⅝ in.
Piston rods	Extended
Piston rods, material	Nickel steel
Crank pins, material	Coffin process
Pistons	Cast steel
Guides, width	9½ in.
Guides, material	Wrought iron
Smoke stacks	Cast iron
Cab	Steel
Truck wheels	McKee-Fuller
Truck wheels, diameter	33 in.
Truck axles	Iron
Truck axle journals	6 by 10 in.
Tender capacity, water	5,000 gals.
Tender capacity, coal	10 tons
Tender trucks	Fox
Tender wheels	McKee-Fuller
Tender wheels, diameter	36 in.
Tires	Krupp
Boiler covering	Franklin Mfg. Co.
Brake	Westinghouse

The size of the electric motors in a system of electric subdivision of power has an important effect upon the ultimate economy of the plant; this has been shown by Mr. George Gibbs in this country and by Mr. John S. Raworth in England, before the Manchester Association of Engineers. Mr. Raworth says that the whole question is bound up in the cost and efficiencies of the various sizes of motors. For instance, it may be perfectly easy to show that 40 horse power may be economically transmitted to a distance and reproduced by a motor of 90 per cent. efficiency. But if the same power is required to be much subdivided and reproduced by motors having an aggregate cost of three times as much as that of the single motor and having an efficiency of no more than 75 per cent., then the balance may be on the wrong side. For instance, if a motor of 20 horsepower costs $750, 20 motors of one horsepower each would cost $2,400, to which extra switches and fittings should be added.

A new use for the stereopticon method of instructing and examining railroad employees has been found. Mr. W. J. Murphy, originator of this idea, has sent us a copy of a letter received from Prof. F. P. Anderson of the mechanical engineering department of the State College of Kentucky, at Lexington, stating that this method will be used in instructing the students of that college in the meaning of railroad signals.

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MASTER MECHANICS WANTED.

Why is it that four important railroads, and perhaps more, are having difficulty in securing satisfactory Master Mechanics? We have at the present time four such applications on file in this office, one of the positions having been vacant for several months. The salaries offered are good, the openings are excellent and the prospects for advancement encouraging. In one of these cases $3,000 a year will be paid to the right man.

Is the fault with the roads, in neglecting to educate young men for promotion? Is it with the technical schools in any way? Is it with the young men themselves? It is clear that something is wrong, perhaps with one and perhaps with all of these. The questions are offered to those whose success and usefulness are closely concerned in answering them.

The compound locomotive has had no more earnest and competent supporter than Mr. F. W. Webb, of the London and Northwestern. Prof. Goss, in his letter from the Crewe works, in this issue, reminds us that Mr. Webb began his experiments twenty-one years ago and has labored in developing the compound locomotive entirely uninfluenced by any lack of sympathy which he has encountered. It is possible that time will show him to have been far in the lead of English practice in this particular, because, now that the limits of clearances are becoming serious in that country, it will probably be necessary to turn to the compound for the desired increase in power.

In the standardization of locomotive parts Prof. Goss shows Mr. Webb to have been very far-sighted. Seven hundred engines with the same cylinders and boilers represent what he has done in this direction in the matter of general design. He goes even beyond this in the smaller details; for example, there are but two eccentrics on the whole road having 2,800 locomotives. To many this will seem like overdoing the idea. It is not overdone, however, until the standardizing begins to obstruct progress. Probably under Mr. Webb's conditions this has not occurred. There is more danger of too little than too much standardizing in this country.

That the staybolt question is one of the most important of the day in locomotive practice is proved by the statements made in this issue by Mr. F. W. Johnstone, Superintendent of Motive Power of the Mexican Central Railroad. Safety is, of course, first in importance, but the expense of renewal is of itself sufficient to enlist the attention of everyone interested in locomotive maintenance. Frequent inspection is necessary to safety, and when engines must be held at least once in 30 days for this purpose the cost of this item is considerable. The expense of renewing broken bolts is not in itself a very large item, but when it becomes necessary to take down parts to get at the firebox the cost becomes enormous and is probably much greater than is generally believed. Mr. Johnstone's statement that it sometimes costs $10 to renew a single staybolt is alarming and is a satisfactory reason for taking advantage of every opportunity to reduce and overcome the trouble. If Mr. Johnstone's new form of staybolt will accomplish this, and it seems promising, the additional cost of the application should be and probably will be cheerfully borne.

The correspondence from railroad men called out by our discussion of Staybolt Progress in the December issue indicates that the staybolt difficulty is causing no little concern and the contemplation of the effects of the increased steam pressures of recent years does not tend to afford relief to the anxiety. Staybolt material has been sent us by prominent motive power men who desired to know whether it is "the best that is to be had," and whether it is "safe material." This may be taken as a satisfactory indication that slightly increasing expense will be gladly assumed for the protection that is so greatly desired.

Mr. F. F. Gaines, Mechanical Engineer of the Lehigh Valley, has valuable suggestions to offer on this subject, and while his comments may seem somewhat radical to those who have seen only what may be termed average practice, we believe that he is correct and we are glad to print his views on points raised in the article referred to. The burden of proof is on the other side of this question, at least for the present.

Laboratory tests of locomotive boilers do not reproduce road conditions in regard to vibration and oscillation of the engine, and by some this is considered as a serious disadvantage because of its influence in reducing the power of the boiler when on the testing plant. The communication by Prof. Smart, in another column of this issue, is based upon experience at Purdue, and it is interesting to know his opinion that this influence is overestimated. What our correspondent says about the maximum power of boilers is important in its bearing upon boiler design as well as being appropriate in this connection. The real power of a boiler is not that which it may develop for a short time, but for sustained service. It is

not that which may be developed in the first few hours of a run, but the response which may be counted upon at any time when needed, that determines the power of a boiler and the capacity of the locomotive. The grates and firebox are closely concerned in this question.

PAYING FOR WORK DONE.

Is the Piece-Work System Defective?

Piece-work has made considerable headway in this country, and it has accomplished a great deal in the development of industrial enterprises. It is an economic advance which pays men according to their worth and encourages them by bringing immediate results for increased efforts. It tends to increase wages, under certain conditions to promote contentment, to increase output and to save in many ways by making the life of the workmen more promising, and he, instead of counting the hours, reckons the amount of work accomplished. He urges the foreman to keep up with the shop and the foremen does not need to urge the shop. The system does all this and all goes well until a certain point is reached, when a defect appears which those who know most about the subject consider a fatal one. The defect of the day system is that improvements favor the employer only, in piece-work they favor the workman except as the increased output is an advantage to the employer. The defect of the piece-work system with a fixed rate per piece is that it makes no provision for the effects of the inevitable decrease in cost of production brought about by the various improvements which are from time to time introduced. The workman obtains the entire advantage except the one mentioned. The result is one of two things: Either progress in improvement will stop at the point where the men begin to fear a cut in their prices, or the employer, who can never be happy when men are getting the advantage over him, will make a cut in the schedules and sacrifice the confidence of the men. If prices have been carefully fixed at the start this may require a long time, but if there is progress the time will come when the issue must be faced. The employer needs to have a direct interest in the further exertions of the workmen just as much as the men need to have an interest in producing short cuts and suggesting improvements. A piece-work system cannot be considered satisfactory unless it is clearly to the interests of the employer to have the men earn as much as they can.

In a paper by Mr. R. T. Shea, read in November, 1899, before the Western Railway Club, the generally understood advantages of piece-work were outlined and in the discussion Mr. G. R. Henderson, Assistant Superintendent of Motive Power of the Chicago & Northwestern, touched upon what is now being urged as the remedy for this defect in piece-work systems when he suggested that any increase in the product of a day's work (on the day-pay basis) should be divided between the employer and the workman. Mr. F. A. Halsey's plan (American Machinist, March 9, 1899, page 180), is as follows:

"Taking round numbers for convenience, suppose a workman to be paid $3.00 per day of 10 hours and to produce one piece of a certain kind per day. The wages cost of the product per piece is obviously, $3.00. Now, under the premium system the proprietor says to the workman. 'If you will reduce the time on that piece, I will pay you a premium of ten cents for each hour, by which you reduce it.' If a reduction of one hour is made the first result to the employer is to save the wages of 30 cents for the hour which has been saved, but against this is to be placed the ten cents earned as a premium, leaving a net gain of 20 cents to the employer, and a net increase of earnings of ten cents to the workman. Had the premium offered been 15 cents, the result of an hour's reduction of time would have been to save 15 cents to the employer and to increase the workman's earnings by the same amount."

The premium plan fixes a time for a certain piece of work and pays a premium for every hour saved. In practice it has been found safe to count upon cutting down the time of machine work operations by one-half. The standard time and the premium need to be fixed with great care. The standard time must not be too short or the premium too great. Mr. Halsey's experience has shown it to be satisfactory to the workman if he receives one-third of the amount he saves. This plan has the effect of keeping the foremen up to their best work, and it is found to be a greater test of the management than of the men. This plan means that the larger the workmen's wages in a given time the less is the cost of production and the greater the advantage to the employer. The premium plan is apparently applicable to any processes to which piece-work may be applied.

Men have objected to this system because it was considered as piecework under another name, which shows their opinion of piecework. Some such plan as this administered with fairness seems likely to prove to be what the industrial situation needs. Summed up, this may be stated as follows: Work inevitably cheapens and some sort of a premium plan is the only way to reduce the cost of production without cutting prices.

FIBRE STRESS DUE TO IMPACT.

By Edward Grafstrom.

If a piece of iron is inserted in a testing machine, and the pressure which stretches it is gradually increased, the ratio between the elongation and the force causing it may be represented graphically by a curve, the ordinates of which refer to the elongations and the abscissas to the corresponding forces. Many testing machines are provided with recording apparatus automatically drawing this curve, which is characteristic of the material. If the gradually increased pressure in the machine were substituted by a falling weight impinging upon the lower, free end of a vertically suspended bar, a similar diagram would be obtained. According to the law of kinetic energy the falling weight would not come to a state of rest until the work done by the impact had been absorbed, or, in other words, when the work of the external force balances the internal strains, the velocity of the lower end of the bar becomes equal to zero. When the internal strains equal a static load of the same weight, the lower end of the bar reaches its maximum velocity. From this point the work as well as the velocity decreases, until the latter quantity finally reaches its zero-value, when the bar remains at rest for an instant, after which it begins to contract. It would continue to oscillate in a vertical direction, were not the energy consumed in producing heat, structural changes, etc.

By assuming that the elastic impulse is transplanted with an infinite velocity, so that the deformation of the body is instantaneous throughout its structure, and all parts of the body are set in motion and again come to rest simultaneously, the dynamic principles above referred to may be used for determining the fibre stress in a body under impact, providing that the proportional limit is not exceeded. One of the most convenient formulas for this purpose, which has come under the writer's observation, is the one by Mr. John Davidson, presented in a recent number of the "Technical Journal" of Stockholm, Sweden. The results of this formula have been verified by the testing machine, within the limits prescribed, which puts it beyond speculation, and, as it may be new to many, its development will here be explained.

If a body is acted upon by a static force, and this is increased in a certain proportion, N, the deformation as well as the fiber stress will also be increased in the same proportion. If now a dynamic force producing N times as large deformation is substituted for the static force, the fiber stress it produces is obtained by simply multiplying the static fiber stress by N. In order to determine the dynamic co-efficient, N, the work of the external forces is put equal to the work of resistance of the internal strains, for, as already stated, it is under these conditions that the body attains its greatest deformation.

Returning to the example of the vertical bar with a falling

weight impinging upon its lower, free end, and by plotting the strain curve referred to, as in Fig. 1, with P representing the weight, h the height, and y the elongation, the rectangle, A B C O = Ph, gives the kinetic energy, L, of the weight at the moment of impact. The static deformation work, W, caused by P is equal to the triangle, O F E = ½Py. The sum of the work by the external forces at the maximum deformation is then, A B D G = A B C O + O C D G. The internal stresses are represented by the triangle, O G H. Consequently, A B D G = O G H. According to the definition of N, O G = Ny, and G H = N P. O C D G is therefore the same as N Py, and O G H the same as ½N²Py, also A B D G = Ph + N Py. By insertion the equation Ph + N Py = ½N²Py is obtained, from which the value of N is found thus:

$$N = 1 + \sqrt{1 + \frac{L}{W}}.$$

If the external forces are suddenly applied, but without attaining any velocity, L becomes = O, and consequently N = 2,

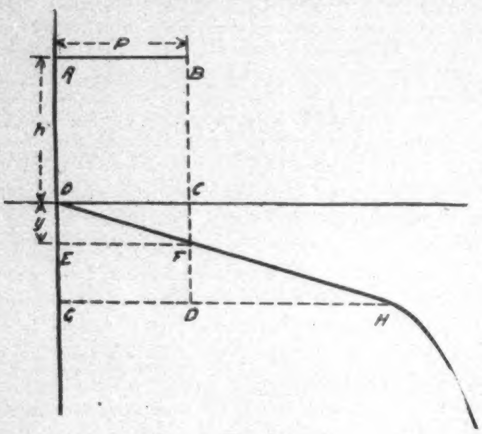


Fig. 1.

or, in other words, the fiber stress becomes twice as large as under the same static load.

The practical application of Mr. Davidson's formula is of wide range, and as it may enable the designer to determine the detail dimensions of machines or structures exposed to dynamic influences more accurately than by experience or from similar analogical conditions, it may be interesting to illustrate its usefulness in the following examples:

Example 1. A vertically suspended iron bar of a length, l = 100 inches, and with a sectional area, A = 1 square inch, is struck at its lower, free end by weight, P = 450 pounds, falling from a height, h = 1 inch. The support as well as the weight are considered inelastic. Find the maximum fiber stress, S.

Here, W = ½Py, if y represents the maximum elongation; y is also equal to Pl divided by AE, where E stands for the modulus of elasticity. W is therefore = P²l, divided by 2A E. If this and the value of L = Ph are inserted in the formula, it will appear thus:

$$N = 1 + \sqrt{1 + \frac{2\,A\,E\,h}{P\,l}}.$$

Assuming E as 27,000,000, we get:

$$N = 1 + \sqrt{1 + \frac{2\,.\,1\,.\,27{,}000{,}000\,.\,1}{450\,.\,100}} = 35.66.$$

The static fiber stress being 450 pounds per square inch, 450 multiplied by 35.66 gives the dynamic fiber stress, S = 16,047 pounds.

Example 2. A beam fixed at one end is acted upon by a weight, P, falling from a height, h (see Fig. 2).

The work of deformation for a strip of the length, x, and the area, q, at the distance, z, from the neutral axis (see Fig. 3), is, as before, and using the same letters:

$$W = \frac{(q\,S)^2\,x}{2q\,E}.$$

If S′ is the stress at the distance z, and S″, the stress in the uppermost element, then S′ : S″ = z : e. Now, S″ = M : I, M and I relating to the distances x and z, respectively, and $I = \int z^2 q$. From this the value of W is obtained:

$$W = \frac{1}{2\,E}\int \frac{M^2\,x}{I}$$

and when the cross section of the beam is constant:

$$W = \frac{1}{2\,E\,I}\int M^2\,x.$$

From this equation the value of N is obtained, according to Mr. Davidson's formula:

$$N = 1 + \sqrt{1 + \frac{2\,E\,I\,L}{\int M^2\,x}}.$$

Inserting the values

$$\int M^2\,x = \int P^2\,x\,Q^2 = \tfrac{1}{3}\,P^2\,l^3$$

we get

$$N = 1 + \sqrt{1 + \frac{6\,E\,I\,h}{P\,l^3}}.$$

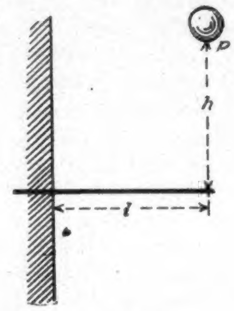


Fig. 2.

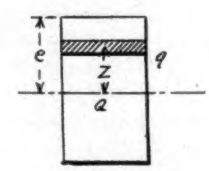


Fig. 3.

Example 3. From what height may the tup in a drop-testing machine fall upon a standard M. C. B. 4¼x8-inch steel axle, without straining the axle beyond the proportionate limit (Fig. 4)?

Inserting the numerical values in the formula, we get

$$N = 1 + \sqrt{1 + \frac{6\,E\,.\,16\;\;O{,}\,0491\,.\,(4\tfrac{5}{8})^4\,.\,h}{1640\,.\,36^3}}$$

which gives

$$N = 1 + \sqrt{1 + \frac{E\,h}{35478}}.$$

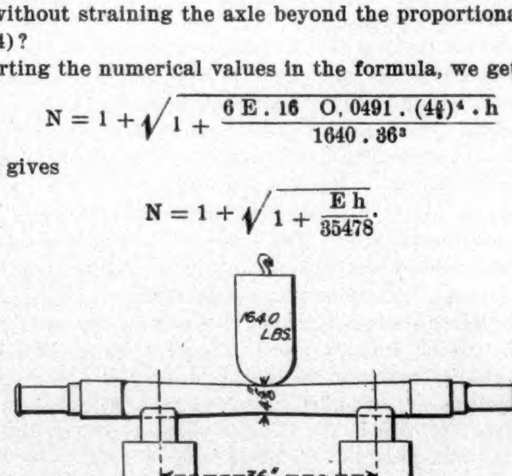


Fig. 4.

The fiber stress under a static load of 1,640 pounds is

$$F = \frac{1640\,.\,4\tfrac{5}{8}\,.\,36}{4\,.\,2\,.\,0{,}\,0491\,.\,(4\tfrac{5}{8})^4} = 1\,520 \text{ lbs.}$$

According to Prof. W. K. Hatt's paper at the Pittsburg meeting of the Association for Testing Materials, the proportionate limit of steel bars under the conditions at hand may be taken as 33,900 pounds, and the modulus of elasticity as 29,386,000. Using these figures, we would have 33,900 = F N, or

$$33{,}900 = 1{,}520\left(1 + \sqrt{1 + \frac{29{,}386{,}000\,h}{35{,}478}}\right)$$

which gives h = O, 54 inches.

EDUCATION OF MACHINISTS, FOREMEN AND MECHANICAL ENGINEERS.

The paper on this subject read before the American Society of Mechanical Engineers in December, by M. P. Higgins, was characterized by Captain Robert W. Hunt of Chicago as the most important paper ever brought before the society.

It is a severe arraignment of the existing order in education for technical mechanical pursuits and is worthy of most attentive consideration from those whose needs this journal is intended to reach.

Many excellent schools are preparing young men to be mechanical engineers, but few are educating machinists and foremen. The need is for these men. One hundred of them are wanted for every one mechanical engineer, and the author's object was to describe a well-considered plan to provide for this vital necessity. His fundamental idea is to base the education on the machinist's trade and without any intention of interfering with the high-grade technical institutions he would make it possible for a boy to become a competent mechanic and at the same time obtain a good school education. Everyone knows the situation with regard to apprenticeship. Mr. Higgins seeks to answer the question: "How can we give our boys a chance to learn a trade without being deprived of a good common school education and at the same time secure a foundation upon which to build a higher education if capacity and circumstances permit?"

He does not propose a new plan to educate the mechanical engineer. He desires to give the machinist's trade and the common education to those who need it, and to do this in a commercially conducted shop which is manufacturing for the open market and is combined with a good school system.

This is a good start for all of the three grades mentioned in the title of the paper. The man who is first a good machinist, trained in a shop which is obliged to frame its conduct on commercial principles, and is qualified to be a foreman, has the best sort of foundation for success as a superintendent and as a mechanical engineer. It is insisted by all that the mechanical engineer requires shop experience and more than he can get in the usual technical school. In view of this we are of the opinion that the high grade technical schools can profitably consider an application of this idea to themselves. There is no doubt that those who start with Mr. Higgins' plan and afterward qualify for mechanical engineering work will be in far greater demand than those who start with the education first and attempt to get the shop experience afterward. To attempt to give even a synopsis of the paper is out of the question here, but we shall try to state its underlying principles.

Mr. Higgins gives the chief features of what he terms the "Half Time School," as follows:

First.—A school which shall include a first class commercially successful and productive machine shop, which is a department co-ordinate in importance, influence and educational value with the academic department.

Second.—A school in which the pupils are to have instruction and practice in this shop during half the working hours in five days of each week for a period of four years.

Third.—Instruction in the public schools during a portion of the other half of the time, equivalent to a high school course, restricted, abridged and improved to meet the needs of these pupils.

Fourth.—Special care and method of selection of pupils who have finished the grammar school course and who have special aptness for mechanical work.

Fifth.—Management under a corporation whose trustees shall be practical business men.

The idea will be new to many, but it is shown to be practicable by the entire success of the Washburn Shops of the Polytechnic Institute of Worcester, Mass., of which the author of the paper has been Superintendent for 27 years. These shops have carried out the idea fully and successfully. This result is in a large measure due to the ability and earnestness of the Superintendent, and it will be difficult to secure such men. They are to be had, however, and it is difficult to understand why the work of teaching should be intrusted to any but those who are best able to do it. This plan means a higher grade of instructors, because they must be men who can hold their own in the competition of commercial affairs. The present college professor has the highest ideals, but it is most difficult for him to keep in touch with commercial conditions unless, as in such a scheme as this, he must do so or fail.

The author says that at a recent meeting of managers it was stated that 200 young men suitable for foremen for foundries could be placed at once. Nothing is more difficult than to find good men for these positions. If, however, a president, a treasurer, salesman or mechanical engineer is wanted, there is no difficulty. The man who is able to manage the practical details of the shop and not only do good work but also do it cheaper than his competitor, is relatively very rare.

The proportion of boys completing courses in the public schools is small, and it is believed that if a good living was assured upon the completion of a four years' course, more would endeavor to take it. The technical schools do not reach this class; first, because the requirements are high and are tending even higher, and second, because these schools are for the scientist rather than the mechanic. This type of school is beyond the reach of boys who are to become workmen and also beyond the reach of many who would make engineers. Mr. Higgins says:

"This school is aimed to fit each boy for the successive grades of mechanics from the machinist up, so that at any time he will be fitted to take up his work outside as a well-trained mechanic in the grade which he has completed, and be prepared to enter the training of the next grade. In other words, the object of the school is to produce many well-trained and educated machinists, and from these machinists some foremen, from the foremen a few superintendents, and finally an occasional engineer.

"'Many are called, but few are chosen.' We need not grieve at the very few chosen, because but few are required. But few professional engineers can be employed, provided the great body of working mechanics are effectively educated to think clearly, keenly and quickly.

"We may hope for much from a thousand educated, thinking, expert American machinists who have the skill, education and an exact knowledge of the shops. Is not the production of one hundred well-educated workmen a more certain undertaking than the production of one genius?

"The hindrance to the best results in engineering schools, which has come from the imperfect and unfair method of selection in making up or enlisting its classes, has already been mentioned. Under the present system it is a boy's business to spend several years of cramming for examinations after he decides upon going to a polytechnic school or college. His whole aim and the aim of his teacher is to prepare for the examinations. The fitting school develops an astonishing ability to pass examinations which are not a true or adequate test of a boy's fitness to make a mechanic or a mechanical engineer. Therefore the entering class of the polytechnic institute consists of a body of experts at examinations, while the boys all through the country who ought to be trained for manufacturing and mechanical industry are overlooked and passed by."

The idea about the shop is to secure as far as possible the conditions which will permit of competing with the best equipped commercial shops in the country, and the organization may be almost the same as if the school element were entirely left out. The Worcester success shows that there are no insurmountable difficulties in the selection of the kind of machines to build or in the manufacture and sale, provided that the management is what it should be. The capacity of the shop should be such that, if desirable, at any time, one-third or one-half as many hired men may be employed as the total number of students. This is one of the fundamental ideas whereby the instruction is surrounded with the real shop atmosphere.

In the light of the long experience of the originator in this field, we are inclined to give weight to the following state-

ment: "We can confidently assure a more thorough expert knowledge of the machinist's trade and a more practical skill in its various departments than is generally secured by any apprenticeship in this country or Europe." The same applies to this also: "These pupils will receive as a part of their shop practice a much larger amount of time in lectures and instruction upon the technical part of the machinist's business than is given in the technical school."

This is a period of transition in educational matters and methods in all lines. It takes time to bring radical changes about, but with the wide and deep interest manifested in this subject in many directions, the necessary improvements can not fail to begin at once to make advances. For a well-considered presentation of a plan drawn up by a man with lofty and sensible views of technical education, this paper is commended to our readers, who are becoming more and more dependent upon properly trained assistants. They should at once take steps to secure copies of the paper from the Secretary of the American Society of Mechanical Engineers. We have, in our editorial rooms, a limited number of copies which will be placed at the disposal of those who ask for them.

CORRESPONDENCE.

THE EFFECT OF THE LOADING OF LOCOMOTIVES ON FUEL ECONOMY.

Editor American Engineer and Railroad Journal:

I have been much interested in the description of locomotive tests on the Norfolk & Western in the December number of the "American Engineer," and greatly pleased to find that the theoretical solution (referred to on page 392, and which was worked up by the undersigned, when connected with the Norfolk & Western) has been confirmed by the practical tests. It was here found that an increase of 20 per cent. in coal burned per ton-mile was caused by an increase in the load hauled of 10 per cent. (page 394). By referring now to page 206 of the June, 1899, issue of the "American Engineer," a load of 700 tons at 10 miles an hour on a 1 per cent. grade should require 47 pounds coal per 100 ton-miles, and a train of 770 tons, or 10 per cent. increase, 53 pounds, or 13 per cent. increase, in fuel consumption. The test was made on a grade of about 1.2 per cent., and this increase in consumption is probably quite logical for these conditions. On a level, an increase from 2,000 to 2,400 tons did not show an increased consumption of coal per 100 ton-miles, and this also corresponds with the diagram on page 206. It must be borne in mind that too great a reduction in the weight of the train will also be accompanied by an increase in the consumption of fuel, as we should pass the economical point of cut-off. In a combination of grades and levels the latter will often be so great a proportion of the total haul that an uneconomical loading for the grade will give an economical train on the level; for instance, a grade 10 miles long, requiring a cut-off of 90 per cent. for a train-load that required only 25 or 30 per cent. cut-off on a level 100 or more miles in length, would evidently not be sufficient to overcome the economical effect of the level haul. The whole subject is one of great interest to motive power officers at this time, and any reports which throw light upon it are heartily welcome.

G. R. HENDERSON,
Assistant Superintendent Motive Power,
Chicago & Northwestern Ry.

Chicago, Ill.,
Dec. 11, 1899.

THE POWER OF LOCOMOTIVE BOILERS ON STATIONARY TESTING PLANTS.

Editor American Engineer and Railroad Journal:

I have read with interest the paper on "Road Tests of Locomotives" presented at the September meeting of the New York Railway Club, by R. P. C. Sanderson, together with the discussion which followed. I find both paper and discussion full of suggestion and information.

There were some statements, however, in the discussion which, it seems to me, call for further remark. The gist of these statements was that, owing to the peculiar conditions under which locomotive boilers operate on the road, it was possible to secure nearly one horse-power per square foot of heating surface; that this condition was probably due to the motion of the boiler, which had a tendency to keep the water solid upon the tubes and thereby prevent priming. Reference was made to laboratory tests of locomotive boilers in which a boiler capable of developing 1,500 horse-power could only be made to show 750 horse-power when tested on a stationary plant. The conclusion drawn from this was that it was impossible on a stationary plant to get as much out of a locomotive boiler as could be obtained on the road.

To those familiar with the operation of stationary testing plants, it is constantly shown that a locomotive boiler may at times and for considerable periods supply steam sufficient to generate at the engine, horse-powers approaching in figures the number of square feet of heating surface contained in the boiler. This, however, does not represent the capacity of the boiler, but is an abnormal condition which cannot be maintained continuously. The true measure of the capacity of the boiler is what it will do for several hours on a stretch, ending in practically the same condition as it started. For this reason, any deductions as to the maximum capacity which may be maintained by a boiler on the road are apt to be very misleading. If the boiler output is figured from indicator cards, those cards may not have represented the average horse-power developed at the cylinder; if it is figured from draw-bar pull, the draw-bar pull may have been an unusual one and not representing average conditions. The very nature of road service, as it affects the boiler, the fact that for certain periods large powers are developed and then time is given to recover and recharge, so to speak, gives opportunity to greatly overestimate the maximum output which a given boiler continuously delivers. For these reasons, the statement made, that it was possible to obtain nearly one horse-power per square foot of heating surface is, it seems to me, open to serious question.

Referring now to the second statement, namely, that locomotive boilers in stationary service or on the testing plant, could not be made to develop the same capacity of which they were capable in road service, I would say, first, that if what has just been said be true, there may have been an error in determining the maximum capacity of which the boiler was capable on the road, and which was said to have been greater than the performance of the same boiler on the testing plant. Second, that it is possible that the stationary test was not designed to force the boiler to its utmost capacity, and, third, that tests have been made on a stationary plant which would seem to show that the capacity of the boiler was not affected by the running of the engine, but was merely a function of the draft.

The movements of a boiler on the road may be classified under three general heads: First, the forward motion along the rails; second, the more or less irregular swaying of the boiler up and down and from side to side; and, third, the continuous and severe vibration of comparatively high frequency and small amplitude. On the testing plant the first of these movements is, of course, absent; the second one is only present occasionally and in a small degree; the third class is, however, present and in about the same degree as in ordinary road service. This has been proven in many ways. It would seem to the writer that if the motions of a boiler have any effect to increase the production of dry steam, that the third, or vibratory movements, would be the most important, in that they would have a tendency to jar the particles of steam away from the heating surface as fast as formed. As has been said, this vibratory condition is to a very large extent present on the testing plant. Tests have been made in which the valves were blocked away from the seat and the steam allowed to blow through the exhaust, which have shown that with a given draft the evaporation of water per square foot of heating surface was practically the same as if the engine were running and the same amount of draft had been produced in the usual way. This would seem to point to the conclusion that the motions of the boiler in service do not have the effect of increasing its output to the extent that would be inferred from the discussion quoted.

R. A. SMART,
Associate Professor of Experimental Engineering.

Purdue University,
Lafayette, Ind.,
Nov. 25, 1899.

RAIL WASHER TESTS ON THE BURLINGTON.

Editor American Engineer and Railroad Journal:

The article on page 380 of the December issue, on the value of the rail washer to remove the sand from the rails as carried out on the Chicago, Burlington & Quincy, is a most interesting one, but I believe the diagrams and tables do not bring out all of the advantages of the device, because the comparisons were made in such a way as to include the grade resistance in the train resistance. On a grade of 1.3 per cent. the grade resistance is 26 pounds per ton, and grade resistance is like death—it is sure. Furthermore, the tonnage must be wrong in the article; the figures evidently should be 396.7 and 302.8 tons instead of 3,967 and 3,028 tons, the decimals having been apparently misplaced. These figures attracted my attention at once because, of course, an engine with a drawbar effort of 12,000 pounds could not pull a 3,967-ton train on a 1.3 per cent. grade.

What I want to call your attention to particularly is that you do not properly bring out the results of the tests by plotting the total resistance. The grade resistance being 26 pounds per ton, is 10,314 pounds in the case of the full train. Then, why not simply plot the train resistance alone? This would show what an enormous effect the sand has. This can easily be done by drawing a horizontal line on the diagram of the full train record at the point of 10,314 pounds drawbar pull. This

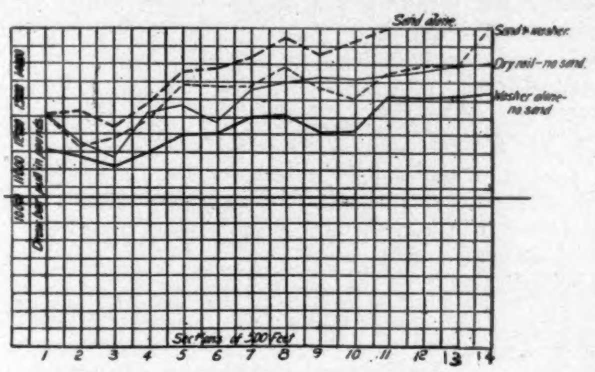


Diagram of Resistances.

introduces somewhat of a difficulty, however. Subtracting 10,314 from the average drawbar pulls given in the table gives results for train resistance as follows:

	Pull in lbs.	Lbs. per ton.	Rating.
Sand alone	3,122	7.85	100 per cent.
Sand and washer	2,554	6.42	82 per cent.
Dry rail	2,197	5.53	70.5 per cent.
Washer alone	1,516	3.82	48.7 per cent.

I consider that the figures for the washer alone look rather small, and you will notice that all of the figures at section 9 on the diagram are low, but they vary together. I should suppose that the train accelerated between sections 8 and 9, thus reducing the drawbar pull; but it is equally fair to all to deduct the grade resistance. The mere fact that the quantities are larger and that the discrepancies appear more noticeably in the total amounts is of no more value than adding an arbitrary 50,000 pounds would be. Put upon the basis of train resistance only, it shows what a valuable appliance the rail washer is.

In confirmation of this, I had a little experience with a very large freight engine on a Western road in testing it on a grade of 1.55 per cent. It was found necessary to use a great deal of sand, which increased the train resistance considerably. I have not the figures at hand, but, if I am not mistaken, the load was increased from 31 to 34 cars by the use of the washer. In this case the water was taken from the tender tank and I do not see why it should be taken from the boiler. The additional heat in this hot water will surely not be enough to avoid freezing in winter, because it is not great as compared with that given out in freezing, and the tank water washed the rails effectively, at least, we thought so.

Chicago, Ill., H. H. VAUGHAN.
Dec. 12, 1899.

[We have reproduced the diagram of the tests with the new base line, as suggested by our correspondent, because the point raised as to the effect of the washer on a level track appears to be a good one. It is understood that in the case of the Burlington the washer is used only on grades, but, to get at the maximum effect of the device, the grade resistance should be eliminated.—Editor.]

LOCOMOTIVE EDUCATION.

Editor American Engineer and Railroad Journal:

Mr. E. L. Coster's communication on locomotive instruction in technical schoosl, page 379 of the December issue, was of special interest to me. This revival of interest in technical schools affects all engineering courses as well as that pertaining to the locomotive, and if there is need for such a revision in locomotive engineering courses, it is even more necessary that improvement take place first in the mechanical engineering course, which forms the basis of locomotive engineering.

Our technical schools are beginning to realize the necessity of up-to-date ideas and commercial methods of conducting the work of the shops and laboratories. During the past ten years they have not kept abreast with commercial improvements. It is for this reason more than any other that such interest is being taken in improving these conditions. We must bear in mind that it is not an easy matter for the professors and instructors of the ordinary technical school to keep up with the best and most modern work and do it by the most improved methods. And probably the only way to bring about such results would be, to put the work as made in the shops and laboratories out on the open market. This privilege should be allowed the colleges of the country as well as the penitentiaries. And when tnis can be done the trouble which railroads experience in getting the right kind of machinists and foremen will be overcome.

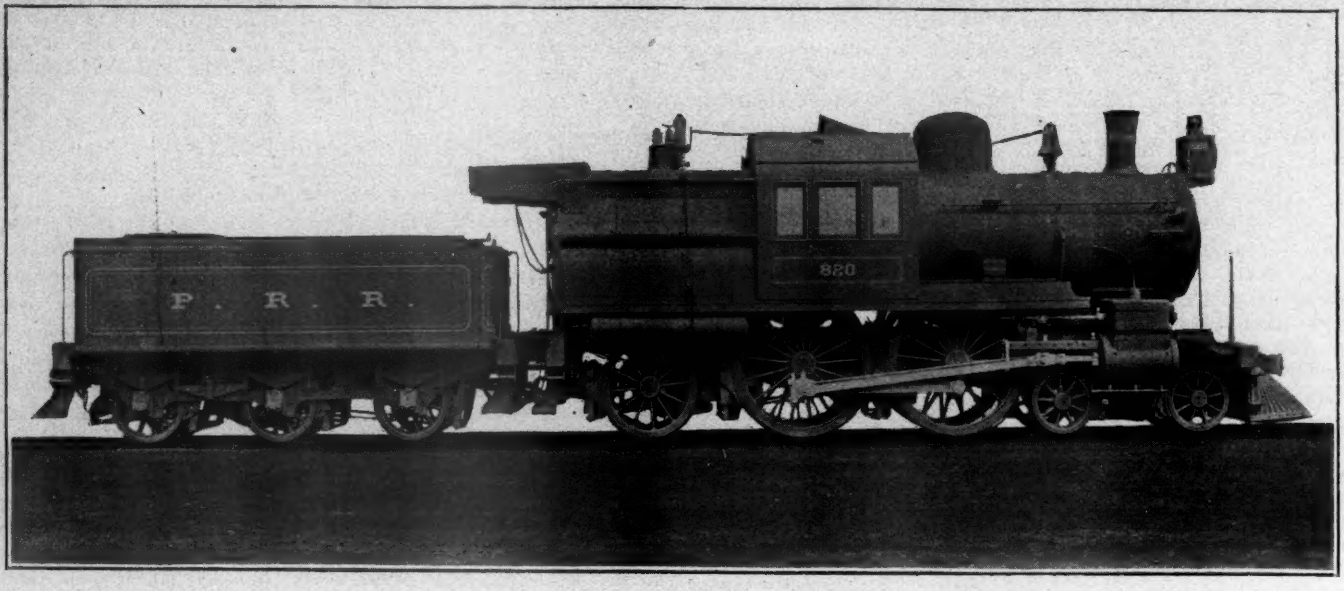
I have at hand a letter from one of the most wideawake technical institutions in the country. And in view of the fact that the school has met in the past with such success in the courses taught, the head of the school is engaged in further revising the courses so as to fit the graduates to meet more nearly the demands of the engineering world. Blanks are being sent to the graduates of the college who are in positions to give, from their three to four years of practical experience, the information desired. These blanks contain six questions which are to be answered and returned with any additional suggestions which may be offered. The questions asked are as follows.

1. Name the course and class in which you graduated.
2. Name the subjects in your course which you think have proved of most practical benefit to you.
3. To which studies do you think we should give more time than we now allow? Name in order of importance—most important first.
4. Name the subjects of least value to you, in order of importance—least valuable first.
5. Which subjects in the course would you retain, but give less time to them?
6. What subjects would you omit altogether from the course?

These questions may prove suggestive to other technical institutions. CHIEF DRAFTSMAN.

Chicago, Ill.,
Dec. 15, 1899.

A bright idea in piece-work was devised some time ago by Mr. E. E. Davis, Assistant Superintendent of Motive Power of the New York Central, while he held a similar position on the Philadelphia & Reading. The men who used material were put on piece-work and those who prepared the material were working on the day-rate system. The result was that the piece-workers kept hurrying the day-workers to keep up the supply of material so that their wages would not be made to suffer for lack of work. This is an excellent illustration of the operation of the piece-rate system and it was also a bit of good management.



Fast Passenger Locomotive—Pennsylvania Railroad—Class E1.

ATLANTIC TYPE FAST PASSENGER LOCOMOTIVES.

Pennsylvania Railroad.

Class E 1.

The magnificent new Class E 1 Atlantic type engines of the Pennsylvania which were completed last summer have been making excellent records in the development of great power at high speeds. Mr. Theo. N. Ely, Chief of Motive Power, has kindly supplied us with a photograph and diagram of one of them and particulars concerning the fast runs made on the West Jersey & Seashore Division. These engines were built at the Juniata shops and are of the best possible workmanship. They are handsome in appearance and the design in every particular reflects the characteristic and broad-minded intelligence of the officers of the mechanical department.

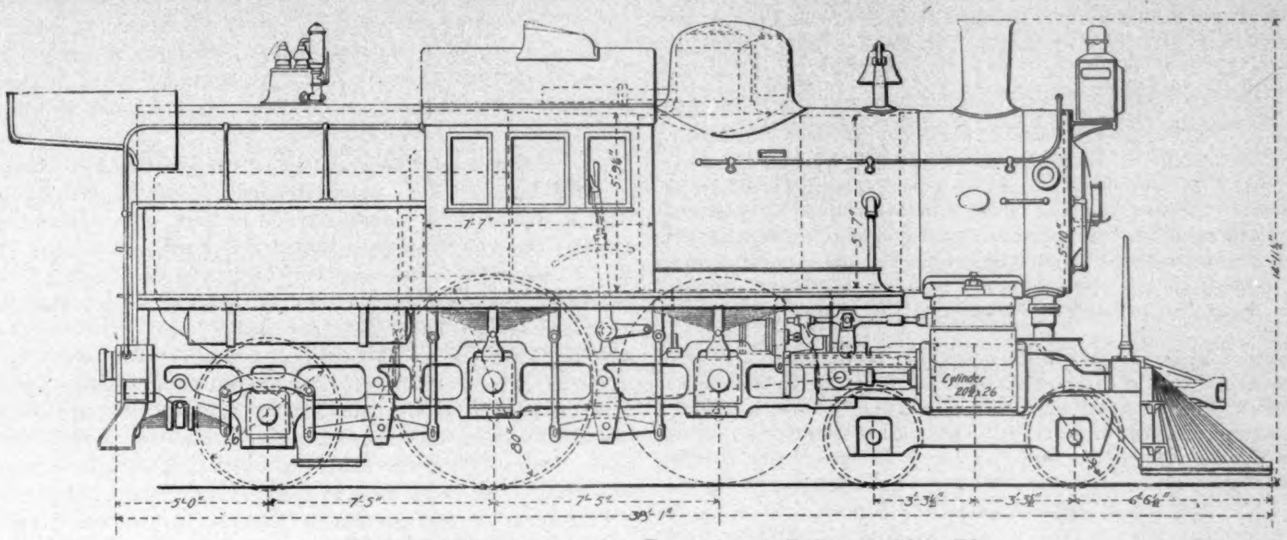
The principal dimensions of the engines are as follows:

Number of pairs of driving wheels	2
Diameter of driving wheels	80 in.
Size of driving axle journals	9¼ in. and 8½ in. by 13 in.
Length of driving wheel base	7 ft. 5 in.
Total wheel base of engine	26 ft. 6½ in.
Total wheel base of engine and tender	50 ft. 5 in.
Number of wheels in engine truck	4
Diameter of wheels in engine truck	36 in.
Size of engine truck axle journals	5½ by 10 in.
Spread of cylinders	85½ in.
Size of cylinders	20½ in. by 26 in.
Steam ports	1½ in. by 20 in.
Exhaust ports	3 in. by 20 in.
Travel of valve	7 in.
Lap of valve	1½ in.
Type of boiler	Belpaire wide firebox
Minimum internal diameter of boiler	65⅞ in.
Number of tubes	353
Outside diameter of tubes	1¾ in.
Length of tubes between tube sheets	156 in.
Fire area through tubes, square feet	4.33
Size of firebox, inside	104 in. by 96 in.
Fire grate area, square feet	69.23
External heating surface of tubes, square feet	2,102.4
Heating surface of firebox, square feet	218.0
Total heating surface of boiler, square feet	2,320.4
Steam pressure per square inch, pounds	185
Number of wheels under tender	6
Diameter of wheels under tender	42 in.
Size of tender truck axle journals	5 in. by 9 in.
Weight on truck in working order	38,125 lbs.
Weight on first pair of drivers	50,250 lbs.
Weight on second pair of drivers	51,300 lbs.
Weight on trailing wheels	33,775 lbs.
Weight on engine in working order	173,450 lbs.
Tractive power per pound of m. e. p.	149.0
Tractive power with m. e. p. equal to 4/5 boiler pressure	22,052

The boiler has a 42-inch combustion chamber, a wide firebox in which the Belpaire form of staying is retained, a total heating surface of 2,320 square feet, of which 2,102 are in the flues and 218 in the firebox. The boiler is said to weigh, empty, 37,494 pounds. The grate area is 69 square feet and unusually large for this road. The fuel is anthracite coal. The smokestack is short, but it has an extension down into the smokebox to a point about 17 inches from the top of the exhaust nozzle. It has been found advantageous to use this arrangement of the exhaust appliances on this road instead of the plan recommended by the Master Mechanics' Association. The ash pan and dampers have had careful attention; the ash pan is made tight and the dampers are of cast-iron and close fitting. The location of the sandbox within the dome casing, in front of the steam dome, is novel. The casing is elongated for this purpose and it looks well. The dome appears to be large, but not too large for such a boiler.

In many respects as regards details, this design resembles the Class H 5 and H 6 freight engines illustrated in our issue of June, 1899. The front sections of the frames are of slab form, with the same excellent arrangement of cylinders cast separate from the saddle and with the same carefully planned fastenings between the cylinders and saddle and the frames. The frames are of cast-steel and are very strong. The rear portions are 4 inches thick and are reinforced by more material at the jaws. There is but one steam pipe and that makes an S-bend in its upper portion and becomes straight before passing through the diaphragm. It enters the center of the saddle casting in the rear of the exhaust pipe, and at the cylinders on each side, where there is too little space for a single pipe of sufficient size, it branches into two pipes for a short distance. The exhaust connections from the cylinders pass through the frames. This arrangement of steam and exhaust passages is remarkably direct and it should be easy to maintain in good order.

The 80-inch driving wheels are handsome and light steel castings, the truck wheels are 36 inches in diameter, and the trailing wheels 56 inches; yet they do not look large because of the good proportions of the engine. A central cab never looked so well before. These engines have very light pistons, light cross-heads, and the Vogt guide, which has a bearing surface 10 inches wide for the top of the cross-head, and it is enclosed for protection against cinders and dust. The washer of the cross-head pin is in one piece with an oil cup. The main rods are unusually long, and, like the side rods, of fluted section. The back end of the main rod is solid with a block held in place by a half round gib and key, the latter being secured by a clamp and two set screws. The valve rod is supported at the back end and the valve motion is similar to that of the freight engines referred to. The setting of the valves has been studied most carefully and this accounts for the power at high speeds. The lead is made 3/16 inch in the tenth notch, and at that point gives a cut-off of 12 inches. The greatest lead is ¼ inch, in the fourteenth notch, which gives a cut-off of a little less than 5 inches. The valves have a



Fast Passenger Locomotive—Pennsylvania Railroad - Class E1.

travel of 7 inches, 1½ inches outside lap and 5/32 inch inside clearance on each side. This is unusually large and is doubtless very useful in getting rid of the exhaust steam. Among the minor details of the running gear the hanging of the brake shoes at the rear of the driving wheels should be mentioned. The brake cylinders are placed in front of the forward pedestal jaws of the front driving wheels. The truck wheels are also braked.

The truck has a new, and, we believe, a very important feature. The pivot is 9½ inches back of the center of the wheel base and yet the load is carried centrally between the axles and is equally distributed between them. The purpose of this is to lengthen the lever arm of the forward wheels and to reduce the impact of the loading and the consequent wear of the leading wheel flanges. The wheel base of the trucks is 6 feet 7 inches. The truck has a steel center casting to which side frames are bolted. These are spaced 27 inches apart, and to their outside faces the pedestals, in the form of brackets, are bolted. The load is transmitted to the boxes by double equalizers, whose ends are united so that they bear directly upon the centers of the boxes.

The tender has a capacity of 4,000 gallons and is carried on three axles, the rear two being equalized. The tender journals are 5 by 9 inches. The six-wheel type was decided upon because it gives a good distribution of the load and does not shake itself to pieces. The coal is carried on a sloping deck extending entirely across the tender, the front portion of which is level and elevated about 18 inches above the deck of the tender. The tank is very strongly braced to hold the coal when the water is low. The photograph shows the rivet heads whereby the position of this coal deck may be seen. Water scoops are fitted to these engines and they are very satisfactory. The scoop is balanced against the thrust of the water, no portion of it is allowed to touch the sides of the trough, and with it 3,500 gallons have been taken in 10 seconds at a speed of 68 miles per hour.

Mr. Ely states that these engines have done very satisfactory work on the seashore line during the past season with fast and heavy trains. These are scheduled at 60 minutes from the Philadelphia side of the Delaware River and 55 minutes from Camden to Atlantic City, or at the rate of 63.6 miles per hour for the distance of 58.3 miles. As 5 minutes is a rather short time for the ferry trip and the transfer of passengers, the actual running time has frequently been less than that. Mr. Ely sends a statement of some of the fast runs and the weights of the trains. These speeds are remarkable, but they are vouched for, and it is evident that these locomotives take place among the fastest in the world. It is probable that they have not been driven to their limit during the first season. The record is printed below exactly as received from Mr. Ely:

Some Exceptional Runs of Regular Trains Hauled by Class E 1 Locomotives from Camden to Atlantic City, Distance, 58.3 Miles, Pennsylvania Railroad Line (W. J. & S. R. R.).

	July 16.	July 20.	July 31.	Sept. 22
Train No.	269	269	269	269
Number of cars	7	8	8	5
Weight of train empty, lbs.	466,100	538,850	526,640	348,950
Number of passengers	317	306	369	152
Running time, minutes	51	53	50½	52
Rate of speed for whole distance	68.6	66.	69.3	67.2

Portions of Above Runs that Were Made at Unusually High Speeds.

Date.	Between.	Distance. Miles.	Time. Min.	Miles per hour. Rate of speed.
July 18	Winslow Junction to Absecon	24.9	18	83.
	Winslow Junction to Drawbridge.	30.6	23	79.8
July 20	Winslow Junction to Drawbridge.	30.6	24	76.5
July 31	Winslow Junction to Drawbridge.	30.6	22½	81.6
	Winslow Junction to Absecon	24.9	18	83.
Sept. 22	Berlin to East Hammonton	16.8	14	72.
	East Hammonton to Absecon	18.7	12	93.5
	Berlin to Pomona	30.	22½	83.1
	Waterford to Pomona	23.7	16½	86.
	Hammonton to Pomona	16.2	10½	92.
	Elwood to Pomona	10.1	6½	93.

Office of the Chief of Motive Power, Broad Street Station, Philadelphia, September 30, 1899.

WHY THE U. S. NAVY ADOPTED WATER-TUBE BOILERS.

The reasons for adopting the water-tube boiler in the U. S. Navy are very admirably set forth in a paper by Admiral Geo. W. Melville before the Society of Naval Architects and Marine Engineers, in which the speaker first expressed his opinion that water-tube boilers are bad in principle, as a failure in a tube is followed by the opening of a fault, while in a fire-tubular boiler the pressure would continue to close a split tube; but on the other hand he considers that the value of their advantages has been sufficiently developed in the last two years to necessitate their use, if we do not wish to be left behind in naval design.

In the fitting out of two ships of identical qualities, one with cylindrical boilers and the other with water-tube boilers, the latter will be somewhat the smaller and handier—will have less draft, and will cost less, and the facility with which water-tube boilers can be removed or completely renewed without disturbing the decks of protected vessels is of itself enough to justify the adoption of water-tube boilers.

The heating surface has gradually been reduced from 3 sq. ft. per horse-power against 2 sq. ft., which is necessary with cylindrical boilers, to 2.4 sq. ft. of heating surface per horse-power. The speaker dwells to some extent on the failures of

the water-tube boiler instead of showing only their good points, for in so doing he gets most information from them.

He also states that so far as he knows, there is not one failure that can properly be said to have occurred purely as a result of being a water-tube boiler. Admiral Melville heartily believes in water-tube boilers as compared with cylindrical boilers for navy use, and gives the following list of advantages: Less weight of water; quicker steamers; quicker response to change in amount of steam required; greater freedom of expansion; higher cruising speed; more perfect circulation; adaptability to high pressures; smaller steam pipes and fittings; greater ease of repair; less danger from explosion; and it is evident that he considers the Babcock & Wilcox type as being specially favorable. He states the disadvantages as follows:

Greater danger from failure of tubes; better feed arrangements necessary; greater skill required in management; units too small; greater grate surface and heating surface required; less reserve in form of water in boiler; large number of parts; tubes difficult of access; large number of joints; more danger of priming.

The opening lecture for the current year in the course of special railway lectures at Purdue University was given on November 28th by President George B. Leighton of the Los Angeles Terminal Railway. President Leighton's subject was "The Work Ahead," and his talk was a brief outline of the opportunities in prospect for those entering railway work. After a short review of the notable events and inventions in railroading in the past, President Leighton discussed the lines along which the coming engineer must work and in which the chances to distinguish himself will be the greatest. The subject is an interesting one and was ably presented.

CAST STEEL BODY BOLSTER.

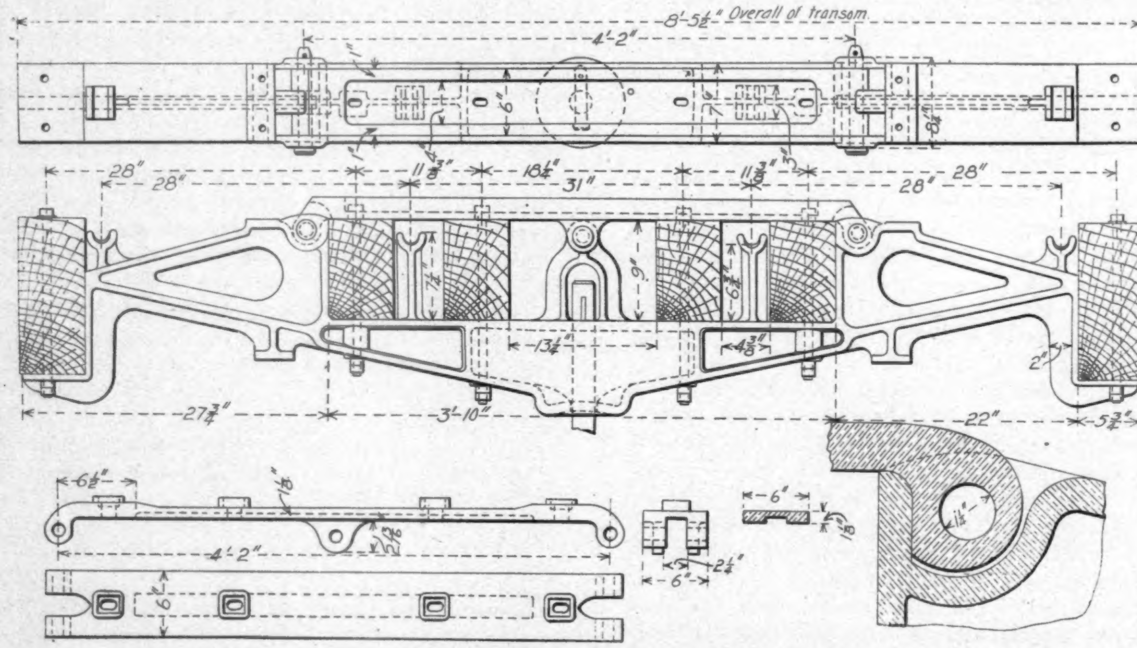
With Separate Tension Member.

American Steel Foundry Company.

The body bolster illustrated in this engraving was designed by Mr. John Hickey, Superintendent of Motive Power, Rio Grande Western Ry., and is made in soft, open-hearth basic steel by the American Steel Foundry Company of Granite City, Ill. These bolsters are relatively light and very strong. During three years of service they have given satisfaction, and no replacements have been necessary, even on account of wrecks. They are now being applied to several different roads.

We have received drawings of two similar designs, one for cars of 80,000 pounds capacity for coal service on the Rio Grande Western, and the other for 41-foot flat cars of 70,000 pounds capacity for the Northern Pacific. The latter drawing was selected as being well suited to engraving.

This form of bolster may be adapted to various arrangements of sills, and the construction permits of taking the bolster down without removing it from the ends of the sills and taking off the end sill for this purpose. The central portion of the tension member is removable, and by taking out pins at the ends and center the bolster may be lowered and replaced whenever this becomes necessary. The center and intermediate sills rest upon a substantial center casting of box form, upon the ends of which triangular extensions carry the end sills and form the upper side bearings. The truss rod bearings



Cast Steel Body Bolster with Separate Tension Member.
American Steel Foundry Co.

are cast with the bolster and extend up between the center and intermediate sills, with those for the outside near the inner faces of the side sills. A saddle which straddles the center pin forms a connection with the tension member at its center. The form of the chief portion of the bolster needs no special explanation, but it seems desirable to indicate that the number of parts is very small; there are but eight pieces in the entire bolster when the pins and collars are included. The upper center plate is integral with the bolster.

The removable tension piece is in the form of a flat ribbed bar six inches wide, with lugs for pin connections at the center and ends. The end lugs are shouldered by an accurate fit to a distance of 3 feet 11½ inches apart to correspond to the shoulders of the pockets in the main casting in which they

An attachment to the nozzles of water cranes for supplying locomotive tenders, to prevent the water from splashing over the tender, has been devised by Mr. Edward Grafstrom, Chief Draughtsman of the Pennsylvania Lines at Columbus, Ohio. As described recently in the "Railroad Gazette," the end of the pipe for a depth of about 5 inches is divided into hexagonal cells by sheet metal partitions. These are sufficient to insure a solid stream from the end of the spout and no canvas or loose funnel appears to be necessary.

The Baldwin Locomotive Works built 104 locomotives in the month of October, 1899, in 26 working days. In November 92 were completed in 25 working days. In 1890 these works built 946 locomotives, on an average of 78 per month, and they were light engines compared with those most commonly ordered now. There are at present 7,250 men employed in this establishment.

rest. The pin holes are drilled and reamed to match closely when the bar is in position and the pins are turned to an easy driving fit. The enlarged sectional view of one of the end lugs of this bar shows its construction and method of bearing.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS.

Annual Convention.

Papers and Discussions.

The final report of the Committee on the Revision of the Society Code of 1885, relative to a Standard Method of Conducting Steam Boiler Trials, was presented and recommended to the society for use in future investigations. It is a valuable document, worthy of the organization. It is probably the best work of the kind ever done.

Professor Thurston presented an elaborate paper, The Steam Engine at the End of the Nineteenth Century, which contained a record of tests on the Nordberg pumping engine. The paper and discussion made clear the fact that the present tendency was in the direction of improving the steam engine in its use of heat, rather than in the improvements of details and construction. Its present development was in the direction of reducing the wastes, with particular reference to the losses of heat which might be turned to account in heating the feed water.

There was nothing worthy of record from this point until the paper by M. P. Higgins, Education of Machinists, Foremen and Mechanical Engineers, was reached. There were six consecutive papers which were practically set aside by the society as not worth discussing, at least nothing of any importance was offered. Mr. Higgins, however, had the honor of presenting not only the really important paper of the convention, but of introducing one of the most vital subjects ever brought before this organization. The paper is given attention elsewhere in this issue. It was clear in an instant that the subject took a strong hold on the meeting and the readiness to accept and thoughtfully consider the difficult problem is encouraging. The education of the machinists and the foremen of the future was the topic, and that the methods of the present do not reach their cases was very plainly indicated. A synopsis of the paper, which is printed in another column, is commended to those who cannot read it in full.

No discussion was offered to the paper on Experiments of Using Gasoline Gas for Boiler Heating, by Herman Poole. The paper on Colors of Heated Steel Corresponding to Different Degrees of Temperatures, by M. White and F. W. Taylor, was discussed to the point that the temperature corresponding to the colors used to represent different heats are so widely different as given by different authorities that conclusions drawn therefrom are not to be depended upon. The apparatus used for determining these high temperatures seems to have been a cause of this trouble, and the eye of the operator must be largely depended upon until this demand for more accurate measurement shall lead to the use of more accurate pyrometric instruments. The paper on a Broken Fly Wheel and How It Was Repaired, by Jas. McBride, also the paper on Fly Wheel Design, by A. J. Frith, were discussed simultaneously. Valuable suggestions were offered to proportioning part of the rim so that the arms will have the proper tension thrown upon them to make the strains equal to those in the rim section. The method of reinforcing the rims of band fly wheels would obviate such cracking in the arm pads and rims of wheels, as was mentioned in the paper. The Efficiency Test of a 125 Horse Power Gas Engine, was the title of an exceedingly good paper by C. H. Robertson, and while the engine tested, which was a Westinghouse, did not show a remarkably economical performance, the tests as conducted were admirable. The three following important conclusions were reached:

First, That the proportion of gas to air is a very important factor in fuel economy.

Second, That one test at a light and one test at a heavy load would serve to locate the line from which an approximate prediction could be made of the gas consumption under intermediate loads.

Third, That these considerations hold for the fuel consumption per brake horse power and per electrical horse power.

The most interesting, but probably not the most valuable discussion of the session, was that on Strength of Steel Balls. The best methods for testing steel balls were considered. The bearing quality of balls was placed second in importance of testing, the quality of elasticity being first. It is not necessary that we know more about the crushing strength than we already know, for if the balls are picked out according to their elastic qualities there will be no danger of the harder balls doing all the work and in consequence, wearing out the bearing. A simple test for sorting balls as to their elastic qualities is to suspend a bar over a steel plate and drop the balls on the plate. Those jumping above the bar at a certain height are used for one bearing and those getting over the bar at another height are used for another bearing.

The paper by F. C. Wagner, entitled Friction Tests of a Locomotive Slide Valve, did not add anything of value to the information already recorded on the subject and the question was raised in the discussion as to whether the tests represented the conditions of practice.

The Friction of Steam Packings, by C. H. Benjamin, brought out interesting tests, but it was indicated in the discussion that as yet no one had succeeded in making tests in which conditions of practice were sufficiently provided for.

The closing session began with the consideration of the subject of impact tests, introduced by a paper by Mr. W. J. Keep, of Detroit. It was an admirable treatment, but apparently too deep for most of the members, as there was no discussion.

Mr. Francis H. Stillman, of the firm of Watson & Stillman, the well-known manufacturers of hydraulic machinery and apparatus, presented a paper entitled "High Hydrostatic Pressures and Their Application to Compressing Liquids; also, a New Form of Pressure Gauge." This paper contained records of experiments on the enormously high hydraulic pressures of 450,000 pounds per square inch which were conducted at the West Virginia Agricultural Experiment Station by Mr. B. H. Hite. They present the startling but apparently conclusive evidence that liquids are compressible, and, under such pressures as this, to quite a considerable extent. Mr. Stillman says that, under a pressure of 65,000 pounds per square inch, water is compressed over 10 per cent. and alcohol over 15 per cent. The question of the compressibility being due to air in the water was raised in the discussion, but it is doubtful if such a precaution as the removal of the air would be overlooked by a careful experimental expert. To experiment with these high pressures it was necessary to enclose the liquids in closed vessels, on account of the deformation which always takes place in a cylinder under heavy pressures. The suggestion with regard to a new high-pressure gauge was the use of the compressibility of liquids to measure the extremely high pressures. Mr. Stillman's paper will doubtless cause a great deal of comment among physicists as well as engineers.

THE MECHANICAL PLANT OF THE BOSTON SOUTH UNION STATION.

The most valuable engineering paper presented in the recent meeting of the American Society of Mechanical Engineers, held in New York City, was that on "The Mechanical Equipment of the New South Union Station, Boston," by Walter C. Kerr, of the firm of Westinghouse, Church, Kerr & Co. This paper covers 115 pages, with the addition of numerous engraved plates, and thoroughly describes the mechanical plant of the new terminal in Boston, to which we have repeatedly referred. The most interesting feature of this work was the fact that it was intrusted to Mr. Kerr's firm, both in plan and execution. The

work covered was the following: Complete system of electro-pneumatic switches and signals. 2. Comprehensive power-house equipment. 3. Electric wiring and lighting system. 4. Heating and ventilating system for the head house. 5. Passenger and freight elevators in large numbers. 6. Ice manufacturing plant. 7. Refrigeration for restaurant, kitchen and storage. 8. Water filtering and cooling. 9. Car heating equipment for train shed, storage and express yards. 10. Compressed air supply for charging and testing train brakes. 11. Fire protection for buildings and train-shed roof. 12. Disposal of storm water and drainage, all of which is pumped. 13. Frost protection for roof conductors. 14. Steam and hot water supply for head house.

The whole of this extensive work was planned and the drawings prepared in 90 days. This and the satisfactory execution of such a contract could have been handled only in this way, without conflict and trouble as well as additional expense. The very substantial amount of $100,000 was saved to the terminal company by the union of interests in the hands of the Westinghouse concern, and the fact that this company was in position to handle this entire contract and supply nearly all of the equipment is a commentary upon the magnificent proportions of the industries instituted by Mr. George Westinghouse. There was no divided responsibility in this case, and the complication of a blizzard, the worst known in Boston for years, which came upon the very opening of the terminal, did not develop a single failure or weakness in any part of the system. The same firm has a somewhat similar work under way at the Pittsburg & Lake Erie terminal in Pittsburg.

This work was not a power house, or elevators, or electric light plant, or ice-making equipment, but a railroad terminal, and everything had been designed specially with this in view. Everything was on a large scale, but the switch and signal plant was the most extensive work of all. It is stated to be the means of saving $30,600 per year in wages alone over the cost of a mechanically operated plant. A conception of the amount of electrical service rendered is had by noting the fact that there are but three cities in Massachusetts, outside of Boston, in which there are a greater number of municipal arc lights than those used by this terminal. The lamps are on 110-volt circuits, while the motors operate on 220-volt circuits. An ingenious three-wire system was devised whereby the two voltages are secured from the generators at the same time. The lighting was divided into 18 sections each, with its separate switchboard. If the attendant at one of these switchboards desired current, he first communicated by signal wires with the power station, and, when the necessary steam and electric units were ready, he was notified from the power house to throw in his switches. This precaution was taken to prevent throwing long loads upon the power house machinery without preparation.

The drainage conductors from the 14 acres of roofs over the buildings were provided with jackets within which small steam pipes were run to prevent them from freezing. The ice plant, with a capacity of 20 tons daily, and 800 tons of storage was the means of saving about $8,000 per year. It was designed to take care of 750 trains per day.

This is the first of what we hope will become a most valuable line of papers for record in the proceedings of this society. In the discusion the prominent feature was the concentration of the entire mechanical work in the hands of one firm. The idea was not pleasing to the consulting engineer, but Mr. Kerr, in a most admirable extemporaneous argument, proved conclusively the advantages in such an undertaking as this. There was room for every man who had talent. It was not advisable to use this method everywhere, but in such a case as this it saved endless confusion, and the economy here was $100,000 in $750,000.

The adoption of the Briggs standard dimensions and screw threads for welded tubes of wrought iron by the Master Mechanics' Association, at the convention last summer, was an important step in view of the amount of this material used by the railroads, and especially because of the interchange of freight equipment upon which so much piping is employed. The condition disclosed by the committee, of which Mr. C. H. Quereau of the Denver & Rio Grande was chairman, was most unsatisfactory, and knowing what the standard is there is every reason why all the roads should adopt it. The Chicago, Burlington & Quincy have adopted it.

PRINTING TITLES ON DRAWINGS.

Labor-saving methods in drawing-rooms are now attracting appropriate attention, and one of the ways of saving valuable time is in the mechanical printing of the titles on tracings. In our August, 1899, issue we described a method used by Mr. F. M. Whyte, then mechanical engineer of the Chicago & Northwestern, and now holding a similar position with the New York Central. Mr. Whyte uses a printing press, and the work is done very acceptably by the cheap (office boy) labor. We reproduce Mr. Whyte's letter on this subject as follows:

"In regard to the use of a printing press for printing titles on tracings, we are using a small handpress for this purpose, the frame of which measures 4 by 6 inches. When it was first proposed to purchase a printing press the one we have was considered sufficiently large; but it has been remarked several times since that it would have been better had we purchased a larger once. The length of the frame given above limits the length of the title, but we find it large enough for the purpose, as we try to make the title as short and expressive as possible. We have three fonts of type, and you can judge of their size by the attached print. We find these sizes of type convenient and quite satisfactory. I might tell you our experience which practically drove us to the adoption of a hand press. First, of course, it costs considerable to put titles on drawings whether the work is done with the usual drawing instruments or freehand. To reduce this cost, we tried first to use a rubber stamp, but the ink which we found would work satisfactorily with the rubber stamp would not give a print, so that, after putting the title on with the stamp, we would have to turn the tracing over and ink it on the back with black drawing ink. This, of course, was no great improvement on putting the titles on by hand. We found we could not use black ink on the rubber stamp, because the gasoline used for removal of the ink from the stamp after using it would destroy the rubber type. It was also difficult to get a perfect impression with the rubber stamp. The first difficulty experienced with the hand press was that the ink would not dry fast enough after the title had been put on the tracing, but this trouble was overcome by using a light, fine powder to absorb the ink, so that we now take a print from the tracing immediately after titling it. Fine powder should be used, because, otherwise, the large flakes of coarse powder will overhang the edge of the letter and produce ragged edges. We use the ordinary quick-drying printer's ink for our press. The first cost for us was $22.50 for the complete outfit, and it is believed that the first month or two's saving would cover the entire expense."

It is necessary to scrape the surface of the tracing cloth for the reception of the printed titles if the drawings are made on the glossy side. Mr. Whyte has sent us the following list for requisitions of printing equipment as used by him, all of which may be obtained from the concern mentioned below:

1 No. 2 Official press 4 by 6 inches.
3 Hemple quoins and one key.
1 lot assorted wood furniture.
5 lbs. 2-point L. S. slugs.
5 lbs. 2-point L. S. leads.
1 8-inch composing stick.
1 8 by 12 inch ink stone.
1 font 6 point combination Gothic type No. 1532.
1 font 18 point combination Gothic type No. 1524.
1 font 12 point combination Gothic type No. 1526.
2 fonts 2 point brass rule.
3 small cases two-third, size (for type).
1 lb. can quick-drying printer's ink.

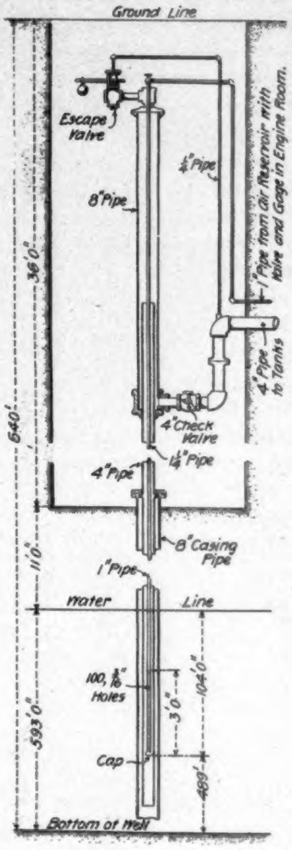
For the benefit of a number of correspondents who have inquired about this method we would state that the press referred to, which is efficient and strong and specially well adapted to such work, was furnished by The Crescent Type Foundry, 346 Dearborn St., Chicago, Ill.

AN AIR-LIFT PUMP.

St. Paul & Duluth Railroad.

Mr. G. D. Brooke, General Master Mechanic of the St. Paul & Duluth Railroad, some time ago devised an application of compressed air to the pumping of water at the Gladstone shops of that road, which is worthy of note. It is an adaptation of the well-known air lift to conditions, under which a deep well pump had not given satisfaction.

The engravings illustrate the plan. The well has an eight-inch casing, driven to a depth of 750 feet, but now partly filled up with silt, making the depth 640 feet. Formerly a deep well pump with a 36-foot pitman was used. This caused considerable annoyance by requiring constant attention, repairs and in replacing this arrangement the location of the well near the stationary boiler plant and in the midst of the shop buildings was found unfortunate, because it necessitated forcing the water underground horizontally to a distance of more than 500 feet to the road water tanks. It would have been better to erect a tank directly over the well, making a vertical lift and then allow the water to flow to the road tanks by gravity. This plan, however, was not followed, for the reason that a fire in the vicinity of the tank over the well would render the water service inoperative.



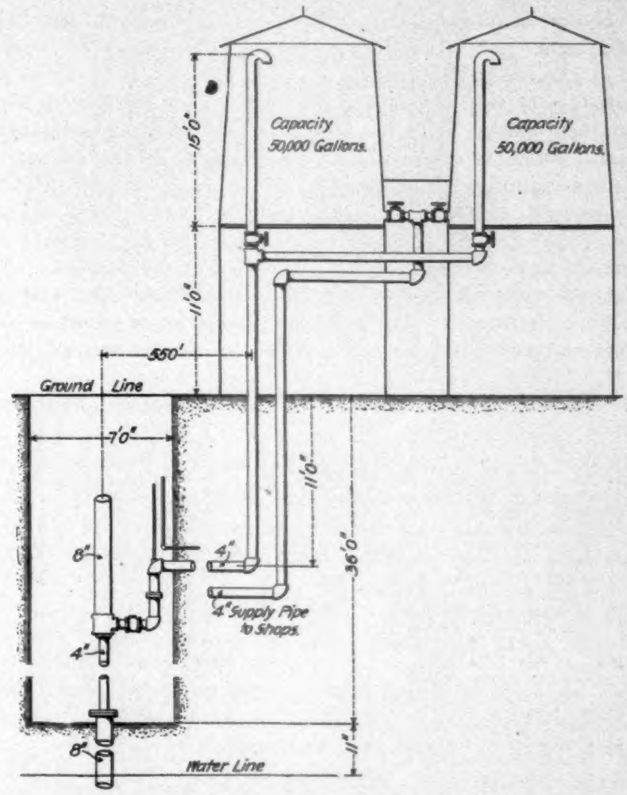
Well Piping.

The arrangement, as installed, places all the apparatus underground, except where there is no liability of fire. The air supply is furnished by a Rand Duplex compressor, and in case of fire in the stationary engine plant supply connections provided for the purpose may be attached for the temporary use of air pumps on locomotives in the round house.

When the air-lift was first started it was the intention to allow all of the air to escape at the over-flow in the water tank, but it was found that the pulsations were so uniform and rhythmical as to cause the tanks to vibrate so severely as to threaten the collapse of the supports if it was allowed to continue. An eight-inch pipe was then added, as shown in the print at the top of the well, and it was fitted with a balance escape valve, which allows the escape of a large portion of the air and retains only enough pressure to force the water horizontally to the tanks and raise it through the remainder of the lift. This arrangement also insures a more solid body of water through the horizontal pipe. Since this change was made, about two years ago, the apparatus has not been changed or even examined in any part, so perfectly has it operated. Mr. Brooke writes that he uses from 80,000 to 100,000 gallons of water per day, the cost of pumping being between five and six cents per thousand gallons. The use of a gravity flow for this horizontal distance would have cheapened the cost, but as it stands, it is not excessive for a lift of 73 feet. The air pressure in the shop piping is 125 pounds per square inch, which is throttled down through a one-inch globe valve to a pressure of 60 pounds for the pumping. A small fraction of a turn of this globe valve supplies enough air from the pressure of 125 pounds to keep a constant stream of water flowing into the tank.

In the drawing it will be noticed that the top of the eight-inch well casing has a tight flange connection with the four-inch pipe; this was not necessary for the perfect working of the device, but it was done to prevent water or dirt from the open well from passing down into the casing, as the water is used for drinking purposes.

As the four-inch pipe and the one-inch air pipes are suspended in the well casing from the top end, double thick galvanized iron pipe was used for this portion to insure against rusting and breaking off and dropping down into the well. The resistance due to 100 feet of water is sufficient to prevent undue vibration of the pipes, which might be caused by the escaping of the compressed air.



Piping to the Tanks.

The number and size of motors to use in equipping a shop with electrical machinery is always an interesting problem. An account of the plan worked out for the new Porifirio Diaz shops of the Mexican International Railway, described in the "Railway and Engineering Review," states that in this case the shafting and machinery of the shops are divided into 10-horse-power units, each unit being driven by a separate motor, while larger or smaller motors will drive individual machines wherever circumstances require. There is an advantage in using a number of motors of uniform size on account of replacements, and it would seem to be possible to group machines favorably for 10-horse-power units. This should be done in such a way as to necessitate using only a few of the motors for ordinary occasions requiring overtime working. The selection of the size of motors is important because the cost per horse-power of the motor increases as the power decreases.

The Hummel system of picture telegraphy is described by Mr. Pierce D. Schenk in a recent number of "The Yale Scientific Monthly." The pictures are drawn with insulating ink on tin-foil and the transmitting and receiving instruments pass in horizontal lines over these plates in synchronous movements. The transmitting current is interrupted at the lines of insulating ink, and the reproduction is made to follow the original. The greatest difficulty was found in synchronizing the two machines. Mr. Schenk illustrates the circuits and instruments with a diagram.

THE OIL ENGINE.

It is about ten years since the first English internal combustion engine, using heavy oil, was brought to the point of success. It was a Priestman engine tested by Prof. Unwin in 1890. burgh, whereby the progress made in this field may be seen, are printed in recent issues of "The Engineer." The Priestman engine referred to made several records, but there is no doubt but that it produced a brake-horse-power for a consumption of one pound of oil. The oils used in the tests were "Daylight" and "Russolene."

At the recent Edinburgh trials 10 engines were tested and satisfactory tests were obtained with nine. There were seven distinct makes. The results are given in the accompanying table, which is of special interest because of the scarcity of data pertaining to oil engines. These tests were made at the Edinburgh exhibition of the Highland Agricultural Society of Scotland. The power was measured by the Prony brake and the indicator, and the oil consumption was measured. The engines were run four hours at the full brake load and two hours at half load. They were afterward run one hour at light load and finally for a short time at the maximum load which could be depended on in an emergency. The Crossley, Stephenson, Pollock and Cundall engines used "Royal Daylight" oil of 0.796 specific, while the others used "Russolene" oil of 0.825 specific gravity.

The average consumption of six of the engines is 0.958 pound per brake-horse-power per hour, which is a small improvement over the earlier results. Four of the engines gave 15.5, 18.93, 12.6 and 18.06 brake-horse-power, respectively, and their mechanical efficiencies were 0.771, 0.773, 0.858 and 0.842, which appears to indicate that these variations in power were not sufficient to affect the efficiencies materially. In other words, the size of the engines, within these limits, does not affect the efficiency.

The half power trials are specially interesting. There were six types of engines represented and the average oil consumption at half power was 1.36 pounds per brake-horse-power hour. One engine used 2.23 pounds. Omitting that, the average would be 1.18 pounds for half power as compared with an average of 0.96 pound for the full load consumption. In overloading it was found that nearly all of the engines developed 25 per cent. overload. No generally satisfactory figures of speeds and pressures were obtained. The generally accepted opinion that high speeds were favorable to high efficiencies because of the short time in which a charge remained in contact with the cylinder was not borne out by the tests. It was found that the best results were given by an engine which ran relatively slowly, while the worst results came with the highest speed. This is not considered by any means conclusive evidence in favor of slow running, however. The tests indicate an improvement in the oil engine, though not very marked or rapid. The wide differences in the opinions as to elementary proportions indicate that the best practice has probably not yet been reached. Ten years is much too short a time to expect to achieve the crystallization of practice which has taken place in marine and other fields of steam engineering.

Summary of Trials of English Oil Engines.

Engines.	Crossley Brothers Limited.	Camp. bell Gas Engine Co.	Campbell gas Engine Co.	R. Stephenson & Co.	Blackstone & Co.	Blackstone & Co.	Blackstone & Co.	Tangyes Limited.	Pollack, Whyte & Waddel.	R. Cundall & Son.
Diameter of cylinder, inches	10	12½	9½	7	6	7	9½	11	10	8¾
Stroke, inches	18	21	18	12	12	14	18	16	18	15
Full-power trial:										
Revolutions per min., mean	204	188	210	252	256	218	190.3	200.1	220.5	227.7
Mean effective pressure, lb. per sq. in	64.52	49.5	..	39.	..	..	56	62.2	..	..
Explosions per min., mean	87.25	76	..	118.5	..	..	81.4	89.75	..	..
Indicated horse-power	20.09	24.48	..	5.39	..	..	14.68	21.43	..	..
Mechanical efficiency	.771	.773	..	.582	..	..	.858	.842	..	..
Brake horse-power	15.5	18.93	13.87	3.14	5.21	8.13	12.6	18.06	10.64	8.77
Oil per B. H. P. per hour, lb	.793	1.20	1.06	1.63	.833	.836	.746	.806	1.15	.962
Half-power trial:										
Brake horse-power	7.71	10.59	6.73	1.31	2.84	4.84	6.59	9.95	4.69	4.35
Oil per B. H. P. per hour, lb	1.037	1.466	1.186	2.88	1.099	1.03	1.024	.939	2.23	1.57
Light trial:										
Total oil used per hour, lb	4.03	8.23	3.8	4.43	1.69	2.75	3.4	3.375	5.375	4.24
Maximum-power trial:										
Brake horse-power	18.01	25.55	14.89	3.14	6.68	10.66	19.7	20.66	19.85	10.54

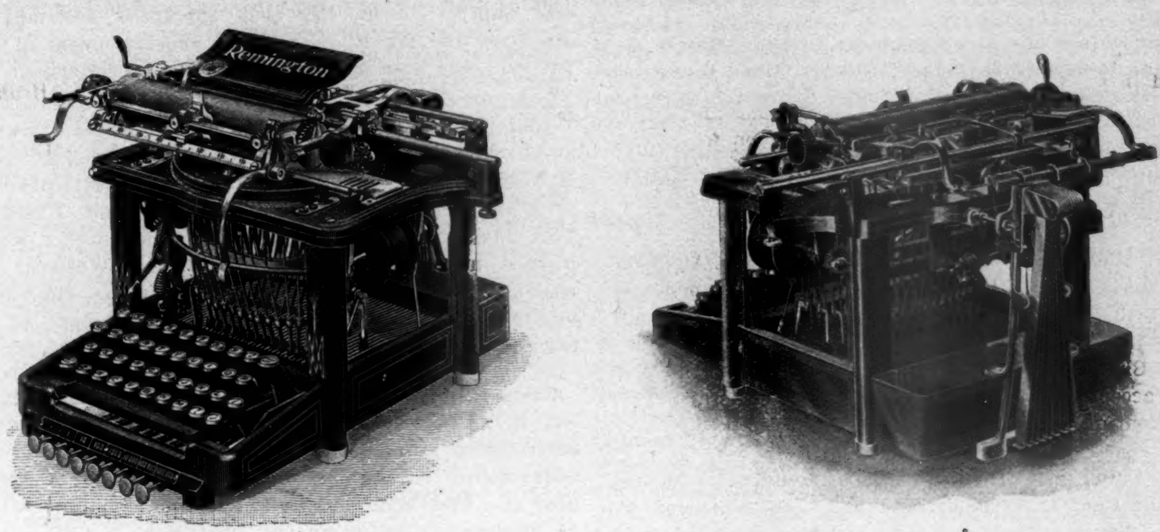
The standardization of the threads of small screws was discussed at the recent meeting of the British Association, and among the interesting facts brought out was the difficulty of making accurate gages for small screws having rounded portions at the top and bottom of the threads. The Sellers standard differs from the threads usually cut on small screws, and also with the Whitworth standard, in this particular. The Sellers standard appears to be gaining friends. It has been adopted by the French navy, and also by several railroads of that country. This system, using flat ended threads, is admirably adapted to accuracy in making gages, and it is possible that further action of the British Association may favor its adoption. It is evident that this organization considers its previous selection of round ended threads as unsatisfactory, and the subject is to receive further attention by the committee having it in charge. The report contains the statement that: "As far as easy production of the correct form is concerned, arguments which apply to large screws apply with greater force to smaller screws, while a form which is suitable for all screws above 6 millimeters diameter, the maximum diameter in the British Association list, cannot be unsuitable for screws below that diameter."

THE NEW REMINGTON BILLING AND TABULATING ATTACHMENT.

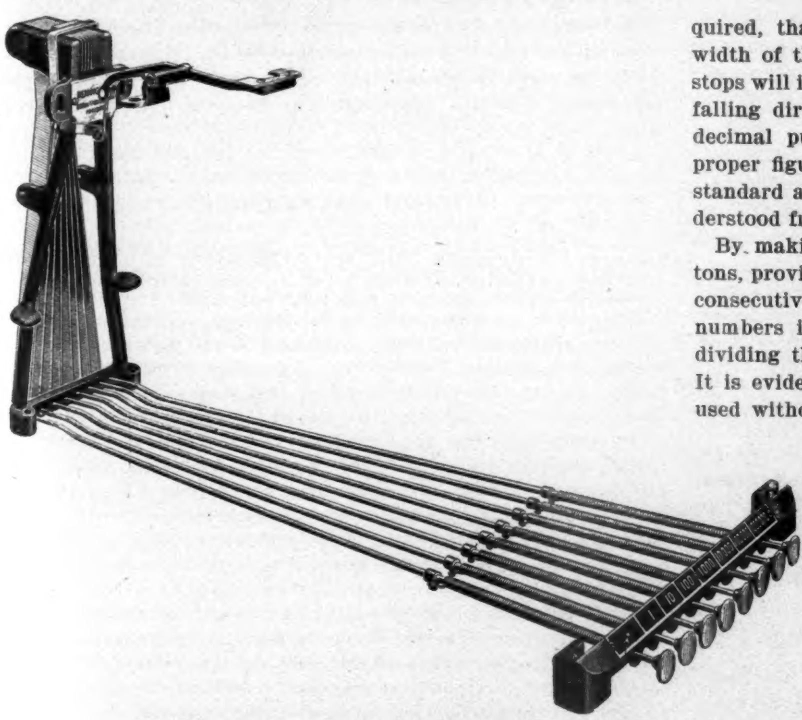
An ingenious and exceedingly valuable improvement has been applied to the Remington Standard Typewriter, which will be an important labor saver in offices where statistical and tabulated work is done. For railroad offices it will be invaluable in preparing reports, records and specifications, one operator working with the attachment can do the work of about five without it, and the arrangement is designed throughout to avoid interfering with the regular operation of the machine. The purpose of the device is to enable operators to arrange tables in columns without the necessity of setting the carriage of the machine by hand. Stops are applied in such a way as to bring the carriage to the desired point by a single movement of a key.

As illustrated in the engraving, the attachment is applied to the machine by small castings fastened to the frame, one under the front of the base below the keyboard and the other in the form of a bracket at the rear of the machine. An additional graduated bar is supported upon the back of the carriage by light brackets, the graduations in this bar being made to correspond with the other graduated scales. Upon this graduated bar small stops may be secured in any desired position for fixing the location of the columns of figures, and these may be changed at any time. Supported in a case in the rear of this bar are a number of plungers, any one of which may be drawn forward horizontally by means of the corresponding push button at the front of the machine below the keyboard. Upon pressing one of the push buttons the pinion which holds the carriage in the ordinary working of the machine is disengaged and the carriage moves along under the impulse of the main carriage spring, which constantly

urges it toward the left. The push button at the same time projects its plunger forward into the path of the stops, and the motion of the carriage is arrested by the stop at the point determined by the push button, which has been operated. For



The Remington Billing and Tabulating Attachment.



The Remington Billing and Tabulating Attachment.

example, if 100 is to be written, the 100 button is pushed and the carriage moves at once and is arrested at the space determined by the location of the stop on the back of the machine necessary to bring the first figure in its proper place in the column. If three columns of figures are to be arranged across the page the stops are placed at the proper places in the rack and the operator starts with the carriage at its extreme right-hand position. The push-button corresponding to the first figure in the first column is pushed and the carriage immediately takes the position desired. The proper numerals are then written from the keyboard, and, upon pressing the push button to locate the first figure in the next column, the carriage at once moves over the intervening spaces and stops at the correct position for the first figure desired for that column, the same process being repeated for the third column. The basis for the columns is a fixed point, which in the standard arrangement is the decimal. The decimal plunger stops the carriage at that space and the other plungers stop it at the proper distance away for the first figure of the desired number. If it is 100, the carriage stops three spaces away, and four spaces if it is 1,000.

It will be noted that no hand setting of the machine is required, that the number of columns is limited only by the width of the paper and the size of the machine, and that the stops will insure the determining spaces for each line of figures falling directly under each other. For decimal fractions the decimal push button is used, the period is struck, and the proper figures inserted. There are eight push buttons in the standard arrangement, and their operation will be readily understood from the engravings.

By making slight changes in the marking of the push buttons, provision may be made for placing the number characters consecutively, for spacing them for commas to divide large numbers into hundreds, for using the monetary sign, or for dividing the figures for pounds, shillings, and pence sterling. It is evident that a large variety in the arrangement may be used without changing the number of the plungers, and more plungers may be added if necessary. For certain kinds of work requiring several different settings of the stops a graduated bar may be used, which is arranged to be revolved into any one of four positions, bringing into play in each position a separate set of stops fixed for the special requirements. For ordinary use the removable stops are preferred, because they may be placed in any notch in the graduated bar. When put in position these stops lock themselves, so that they cannot be jarred out of place and yet they may be easily removed by the thumb and finger. The improvement was brought out about a year ago and has been brought to a satisfactory working condition. Mechanically, the device is well designed. It does not interfere with any operation that could be done before, and it may be very quickly applied to any of the recent models of these machines.

EXTENSION OF SEVEN MONTHS FOR SAFETY APPLIANCES.

The extension of the time for equipping cars with automatic couplers and air brakes, petitioned for by the railroads, has been granted by the Interstate Commerce Commission, and the date thus fixed is August 1, 1900, an extension of seven months. Expected progress has not been made by a number of roads because of the difficulty of procuring the necessary material and also because of the enormous traffic of recent months, which made it impossible to get the cars into the shops for making the attachments.

PERSONALS.

Mr. S. B. Mason has been appointed Assistant to the Mechanical Superintendent of the Baltimore & Ohio, with office at Mt. Clare, Baltimore, Md.

Mr. W. S. Haines has been appointed Division Master Mechanic of the Baltimore & Ohio, at Newark, Ohio, to succeed Mr. W. H. Harrison.

Mr. H. E. Yarnall, Purchasing Agent of the Choctaw, Oklahoma & Gulf, has removed his office from South McAlester, I. T., to Little Rock, Ark.

Mr. H. V. Mudge, General Superintendent of the Atchison, Topeka & Santa Fe, has been appointed General Manager of that road, with headquarters at Topeka, Kan.

Mr. F. S. Chandler, formerly Purchasing Agent of the Ann Arbor, has accepted a position in the office of General Superintendent Stout of the Wheeling & Lake Erie.

Mr. C. E. Fuller has resigned as Superintendent of Motive Power of the Central Vermont, and has been succeeded by W. D. Robb, hitherto Master Mechanic of the Grand Trunk at Toronto.

Mr. James H. Maddy, who has done such valuable work as Press Agent for the Baltimore & Ohio, has been rewarded by appointment to the position of assistant to General Manager Underwood.

The office of Master Mechanic of the Lake Shore & Michigan Southern, at Buffalo, N. Y., has been abolished, and the jurisdiction of Master Mechanic A. A. Bradeen is extended to include the entire Eastern and Franklin Divisions.

Mr. F. H. Clark, Chief Draughtsman of the Chicago, Burlington & Quincy, has been appointed Mechanical Engineer of that road, with headquarters at Aurora, Ill., and will be succeeded as chief draughtsman by Mr. C. B. Young.

Mr. Malcolm H. Wallace, Chief Clerk of the Motive Power Department of the Northern Pacific, has resigned to accept the position of Chief Clerk to Mr. E. M. Herr, General Manager of the Westinghouse Air Brake Company, at Pittsburg.

Mr. G. J. Fisher has resigned as Purchasing Agent of the Fitchburg, to take effect on January 1. He has held this position for the past 12 years and was formerly Purchasing Agent of the Eastern Railroad and the Boston & Maine.

Mr. William F. Merrill, Second Vice-President of the Erie, has been chosen First Vice-President of the New York, New Haven & Hartford, to succeed Mr. William D. Bishop, Sr., who has been filling the position temporarily since November 11. Mr. Merrill will have direct charge of the line and its operation.

Mr. S. S. Voorhees, who has been chemist of the Southern Railway for the past five years, has been appointed to a similar position on the New York Central at West Albany. His experience before entering the service of the Southern Railway was with Dr. C. B. Dudley, with the Pennsylvania, at Altoona. He is a graduate of Lehigh University.

J. Charles Cox, the news of whose death, in November,, reached us after the publication of our December issue, was 72 years of age. He died in Pittsburgh, where for many years he was employed by the Pittsburgh and Connellsville Railroad. He was subsequently connected with the Baltimore & Ohio when that road absorbed the Pittsburgh & Connellsville.

Recent changes in the operating department of the Chicago & Northwestern are as follows: Mr. J. M. Whitman, for many years General Manager, has been made Fourth Vice-President; Mr. W. H. Gardner, Assistant General Superintendent, has been appointed General Manager; Mr. Sherburn Sanborn, General Superintendent, has been appointed Assistant General Manager, and Mr. R. H. Aishton, Superintendent of the Iowa Division, has been appointed General Superintendent.

John I. Blair, the veteran railway builder and owner, died at his home in Blairstown, N. J., December 2, at the age of 97 years. He began his career as a railroad builder in 1839 in a connecting link between Oswego and Ithaca, N. Y. This line, with others which he aided in building, was finally merged into the Delaware, Lackawanna & Western, in which he was a director at the time of his death. He was prominently connected with the construction of many of the important roads in the West.

Colonel Julius Walker Adams died at his home in Brooklyn, N. Y., on Dec. 14. He was one of the most brilliant and enterprising men in the field of civil engineering. He was instrumental in establishing civil engineering on this continent as a profession and was one of the fathers of the American Society of Civil Engineers. In 1846 he was Superintending Engineer of the New York & Erie Railroad, for several years Consulting Engineer of the City of New York, and prior to this time was Chief Engineer of many other Eastern roads. Colonel Adams was born in Boston, Oct. 18, 1812, and has lived a life of such usefulness that one cannot but feel the great inspiration his life and work has been to the engineering world.

BOOKS AND PAMPHLETS.

Masonry Construction. By Ira O. Baker, C. E., Professor of Civil Engineering, University of Illinois. Ninth edition, revised and partially re-written; first thousand. Published by John Wiley & Sons, New York, 1899.

This book has long been a standard work, and an acknowledged authority on foundations. The present edition is a revision for the purpose of bringing the text on cements, mortars, concrete, etc., up to the present state of knowledge on those subjects. The treatment of cement tests and cement specifications is as complete as one could wish; the same cannot be said of the discussion of concrete, but the indefinite state of knowledge on this latter subject makes it very difficult to secure reliable data. It is noticeable that no information is given regarding the expansion and contraction of concrete with changes of temperature.

The importance of allowing for the expansive force of concrete is shown by the experience of some cities where concrete walks have been laid abutting against the street curbs at crossings, and have by their expansion broken the curbs. Examples of this action may be seen in Indianapolis, and also in Grand Rapids, Mich. At Ann Arbor, Mich., the expansion in a concrete walk one-quarter mile in length was sufficient to cause buckling at one joint, the joint being forced upwards six or eight inches, leaving the two adjacent blocks of concrete inclining against each other. The importance of this element in concrete is also emphasized by the growing use of Melan and Thacher arches of steel and concrete combined, in which the stability of the structure depends to some extent upon the assumption that the coefficient of steel and concrete is practically the same, a very doubtful assumption. Spaulding says that the coefficient of expansion of neat cement is the same as steel. It would seem, then, as though it would be considerably less for concrete, with its large proportion of stone with low coefficients of expansion.

The book may be criticised for neglecting in a discussion of arches, which in other respects is quite broad, any mention of Melan and Thacher bridges, or arches of concrete, when everything seems to point to the rapid development of these structures for highway bridges.

Some important data are given regarding the relative

strength of Portland and natural cements which does not uphold the doubtful theory held by some, that natural cement concrete becomes stronger in time than Portland cement concrete; but the proof is not conclusive. Outside of these few points the text is most satisfactory and complete.

The absorption of water by cements and concrete, with means of prevention, and the effect of freezing on concrete, are discussed at some length. A chapter has been added on sand, gravel and broken stone, with methods of determining the voids for a proper proportioning of cement in the making of concrete.

Although the present edition is a revision with reference to mortar and concrete, it may not be amiss to notice one conclusion that the author has drawn in his discussion of arch culverts, and which might with advantage have been omitted from the revised edition. The conclusion is that because semicircular arch culverts have usually been built with heavier abutments than would be required to resist the thrust of the arch, that therefore it may be concluded that the pressure of the earth-fill against the abutments is far greater than the thrust of the arch; and therefore segmental arch culverts, on account of the greater thrust of the arch to balance this pressure, may be built with lighter abutments than semi-circular ones. It may be true that such is the case, but some more substantial proof is needed to be convincing. And such a conclusion drawn from inspection of existing structures is not only unwarranted but is dangerous.

The Stereopticon Method of Examining and Instructing Railway Employees. By W. J. Murphy, Superintendent C., N. O. & T. P. Ry., Lexington, Ky., 1898. 54 pages, 4½ x 6 inches.

This little book contains questions and answers, engravings and descriptions of the stereopticon method of training and examining railroad employees in regard to the rules governing railroad operation and the management and use of railroad equipment. The author devised this method some time ago, and put it into use on the Cincinnati, New Orleans & Texas Pacific Ry., where it has been very successful. The underlying idea is to instruct and examine the men under conditions as nearly as possible like those of actual visits to the various points protected by signals, and by aid of photographs thrown upon the screen the instructor and examiner is enabled to place actual conditions before the men in a way that could not possibly be attained by diagrams or, in fact, by any method except by actually taking them out on the road to the places where the complications in signals and dangers are to be found. This is manifestly impossible on a large road, but by means of the screen these places are practically brought into the room and placed before the men. Mr. Murphy does not confine his attention to signal and train rules, but reaches out into the subject of breakdowns to locomotives and the handling of wrecks. These matters are not presented in detail or in large variety in this little book, but the treatment is sufficient to indicate the possibilities of the plan. Mr. Murphy's method of examining men as to color blindness and strength of vision by aid of the stereopticon is also shown. This idea of the use of the screen and lantern is believed to be a thoroughly good one, and every railroad officer having to do with the operation of trains should obtain a copy of the book. The idea of the plan is to instruct new men intelligently as to their duties and periodically examine those in service as to their knowledge and understanding of the rules.

Hall's Tables of Squares. Containing the True Square of Every Foot and Fraction Thereof, from 0 to 100 Feet, Advancing by One-sixteenth of an Inch. By John L. Hall. The Engineering News Publishing Company, 220 Broadway, New York; 200 pp., leather, size 3½ by 5¾ inches, 1899. Price, $2.00.

This is a most convenient table of squares. It is a durable and attractive book, well suited for the use of engineers, and possesses several important improvements over other tables of squares. This table is stated to be correct to the sixth decimal place instead of merely to the second or third place, which is the limit of other tables with which we are familiar. The compass of this work is heartily commended. It gives the squares up to 100 feet, whereas 50 feet is the limit of previous tables. An admirable feature of its arrangement which will be appreciated at once is the paging. The page numbers correspond with the number to be squared and the squares of any particular foot and its fraction are exposed to view on two facing pages. This is accomplished by numbering only the left-hand pages. A comparatively small matter of this kind makes all the difference between convenience and inconvenience, and this has a great deal to do with the success of such a work. The arrangement of the columns is also good. Each inch has a column by itself, separated into quarter inches by blank spaces, with the roots printed in heavy-faced type. The clearness produced by this arrangement is unusual. These are an improvement over Buchanan's in that in the present work the fraction is squared first and then reduced to decimal form, whereas Buchanan took for the basis of his tables the approximate 4-place decimal equivalent of each fraction of a foot. Mr. Hall points out that the resulting squares, if absolutely accurate to the eighth decimal place, yet, by reason of the inexactness of the roots employed, differ from the true squares in eleven cases out of every twelve and frequently at the second or third decimal place.

Fowler's Mechanical Engineer's Pocket Book for 1900. Edited by William H. Fowler. Price, $1.00. Published by D. Van Nostrand Co., 23 Murray St., New York.

The success of this book last year has resulted in an increase of matter covering 200 pages, 80 of which are added to the treatment of electrical subjects. The book contains a great deal of valuable information which, even with the present large number of "pocket books," we have not seen in any other publication. Its strong points seem to be such information as would be expected with such assistance as that of the former Chief Shipwright of the Board of Trade and Professor Pullen. The tables of properties of saturated steam are unusually complete in range, for the purpose of providing for the recent great advances in steam pressures. The tables in this volume range from 1 to 300 lbs. per square inch with intervals of one pound, and all the quantities involving the mechanical equivalent of heat are based on 778 foot-pounds, the most recently accepted value. This work was done by Professor Pullen. The other most important additions concern steam boilers, machine tools and textile machinery. The index is satisfactory, covering nearly 50 pages. The price is exceedingly low, and for this reason the presence of a large number of advertisements may be excused. We must criticise the omission of the name of the book upon the binding where it may be seen on the shelf. Doubtless this will be attended to in future editions.

The Building and Ornamental Stones of Wisconsin. By E. R. Buckley, Ph. D., Assistant Geologist Wisconsin Geological and Natural History Survey. Published by the State of Wisconsin, Madison, 1898.

This volume, which has been received through the courtesy of Mr. E. A. Birge, Director of the Wisconsin Geological and Natural History Survey, will be invaluable to those interested in the geology of Wisconsin. It treats of the demand, uses and properties of ornamental stones; the geological history of Wisconsin, and description of the areas and quarries. The appendix contains a study of the composition and kinds of stones and rock structures. The volume presents results of a large number of tests and by aid of handsome engravings and colored plates shows not only the character of the Wisconsin building stone, but its effect in architecture and the methods of quarrying and preparing for use.

Interstate Commerce Commission. Eleventh Annual Report on the Statistics of Railways In the United States for the Year Ending June 30, 1898. Prepared by Mr. Henry C. Adams, the Statistician to the Commission. Government Printing Office, Washington, D. C. 1899.

This report covers the ground of railroad statistics in accordance with the plan adopted by the commission and brings the record up to a little over a year ago. It appears to have no new features, but is undoubtedly improved in accuracy by the efforts to secure data in a uniform manner from the various combinations of roads which naturally tend to obscure the identity of some of the individual lines. It contains the report of the statistician, statistical tables; a summary of railroads in the hands of receivers, with the capital involved; decisions of the commission upon questions raised under the classification of operating expenses, and two indexes, one to the railroads and the other a general index to the volume.

Report of the 18th Annual Meeting of the American Street Railway Association Held in Chicago, October, 1899. Mr. T. C. Pennington, Secretary, 2020 State Street, Chicago, Ill.

This pamphlet of 220 pages contains the minutes and proceedings of the recent meeting of the association, with complete information concerning the membership, and includes the papers and discussions of the meeting.

Locomotive sanders are illustrated and described in a pamphlet of 30 pages received from the American Locomotive Sander Co., 13th and Willow streets, Philadelphia. The devices described are the Leach, Houston, Dean, "She" and Curtis. These well-known sanders are all described in detail by the aid of line drawings showing sections of the apparatus.

The Rand Drill Co., 100 Broadway, New York, have issued two very handsomely illustrated pamphlet catalogues, one entitled "Rock Drills and Drill Mountings," and the other, "Air and Gas Compressors." The first is devoted to the rock drill in its various forms for mines, quarries and tunnels. It contains a history of the rock drill, descriptions of the machines manufactured by this firm, illustrations of different kinds of works, and valuable information for use in connection with this work. The compressor catalogue illustrates the Rand Air Compressor in its many forms and applications, the descriptions of which include tables of information concerning sizes and capacities. The accesories to compressors, reheaters, air engines and governing appliances are included, and also a number of tables of information concerning the compression and use of compressed air. The engravings are unusually fine; nearly all are half-tones.

Westinghouse Pneumatic Control, New Motor Trucks and Rotary Air Compressor.—The Westinghouse Air Brake Co. have issued a most handsomely illustrated pamphlet on these subjects. The pneumatic control system for elevated railroads is described in detail and by aid of the engravings the operation of this ingenious system is made clear. The object is to use motors under any desired number of cars in the train which may all be controlled from the motorman's compartment of any of the cars. The controllers are operated by pneumatic power acting in small cylinders, the operating valves of which are controlled by currents from primary electric batteries. The system uses the principles of the Westinghouse electro-pneumatic interlocking apparatus and in a really simple system permits of obtaining the advantages of multiple unit control of an electrically driven train. The pamphlet also describes the air brake system applied to such service, which is a modification of the standard apparatus used in heavy railroad service and the new rotary air compressor which is driven directly by a motor placed with its armature horizontal. Heretofore the independent compressors for elevated car service have been of the reciprocating piston type and driven by gears or other noisy mechanisms. This is a rotary air pump and the motor is made specially for use in connection with it. We also find an illustrated description of the new Baldwin-Westinghouse motor truck (See American Engineer, November, 1899, page 356) and several engravings of the large Westinghouse railway motors used in recent practice. The pamphlet is the handsomest that we have seen in such literature, and is in excellent taste throughout.

EQUIPMENT AND MANUFACTURING NOTES.

The Chemins de fer de l'Etats Neerlandais, at Utrecht on the Rhine, has adopted Nels' yellow semaphore signal lights and has ordered the glass from Mr. John C. Baird of Boston.

The Chicago Pneumatic Tool Co. announces the dismissal of patent litigation entered into between that company and Joseph Boyer with the Standard Pneumatic Tool Co. and the Chouteau Manufacturing Co. The announcement states that the parties concerned have purchased licenses from each other covering their present styles of hammers, a step which was considered necessary for the protection of users of their products. This action will prevent the annoyance from infringement claims.

Mr. Wallace W. Johnson, who has been associated with the Keasbey & Mattison Company for a number of years, has resigned to become connected with the Franklin Manufacturing Company of Franklin, Pa.

The Bullock Electric Manufacturing Co. have begun the extension of their main shop building by the addition of 200 feet to its length. This will make the main shop 500 feet long by 101 feet wide. The increase in facilities has been necessitated by increasing volume of business coming from all parts of the world.

The electric car lighting system of the Columbian Electric Car Lighting and Brake Co. of 11 Broadway, New York, of which Mr. J. L. Watson is secretary, is now in operation on the following roads: The New York Central, Pennsylvania, Baltimore & Ohio, Boston & Albany, Union Pacific, Rutland, Illinois Central, Lake Shore & Michigan Southern, Canadian Pacific, Cleveland, Cincinnati, Chicago & St. Louis, and also by the Pullman and Wagner companies. The system was described in our December, 1899, issue.

The Q & C Co. sent us the following statement in regard to patent litigation concerning pneumatic tools: "Referring to the articles now appearing in the mechanical papers pertaining to litigation on pneumatic tools, and in order to make clear the position of the Q & C Co., we wish to distinctly state that we are not in any way involved in this controversy. The line of tools manufactured by us are protected by our own patents, unique and broad in themselves and absolutely clear from any infringement. Full protection will be given to any purchaser of our tools from any liability on account of their use."

The Cling-Surface Manufacturing Company, of Buffalo, N. Y., report a recent letter from the Peoples' Electric Light, Heat and Power Company, of Greenville, Pa., which says that Cling-Surface gives the best of satisfaction. "One of our 16-inch belts is running with a 21-inch sag. Another 16-inch belt, 8 feet shorter, is running with a 19-inch sag. One of our 12-inch dynamo belts has been run ten years and is a 'dead belt'; we had to cover the pulley or run it very tight. We have been using Cling-Surface on it and no pulley covering, and now it with 8-inch sag and think we can get it down further. Two other 12-inch 'dead belts' are also running very slack."

Having noticed printed references to a circular issued jointly by two manufacturers of pneumatic tools, stating that the patents controlled by them cover the fundamental principles of pneumatic hammers, without which no successful ones can be made, the Q & C Company desires not to express any opinion as to the accuracy of the statement when applied to valved hammers, but to state that it is misleading when valveless hammers are included. They also desire to state that the valveless hammers manufactured by them are not in any way an infringement of the patents referred to.

An index for the M. C. B. book of rules has been prepared by the Sargent Company, 675 Old Colony Building, Chicago, and will be distributed to railroads for the use of those having occasion to refer to the rules. This index is arranged to fold into the book of rules and is provided with a gummed strip for attachment to the page. On the reverse side of the slip is a copy of the Sargent Company's knuckle chart illustrating 59 of the M. C. B. coupler knuckles, which this concern is prepared to furnish. The idea is a good one, and the indexes will undoubtedly be thoroughly appreciated among the railroads. Copies will be furnished upon application to the Sargent Company.

The Bullock Electric Manufacturing Co. report for November, 1899, the largest amount of business in a single month in the history of the company. Fifty-one machines were sold, several of which were "repeat" orders. The more important sales are noted as follows: Willson Aluminum Co., Holcombs Rock, Va., three 600 k.w. alternating generators; Manchester Sporting Chronicle, of Manchester, England, two 150 k.w. direct current generators (second order); L. L. Summers, Florence, Colorado, six direct current generators aggregating 260 k.w.; John Wanamaker, Philadelphia, Pa., one 100 k.w. direct current generator, and three 50 horse power "Teaser" printing press equipments; Arthur Pearson, Pearson's Magazine, London, England, three 50 horse power "Teaser" printing press equipments; Oakland Transit Co., Oakland, Cal., four 15 horse power direct current motors (third order); American Type Foundry Co., Cincinnati, O., one 30 k.w. generator (second order), and Pacific Coast Borax Co., Bayonne, N. J., one 12½ horse power direct current motor (fifth order).